# Consultative Committee for Space Data Systems

**DRAFT RECOMMENDATION FOR SPACE DATA SYSTEM STANDARDS**

## SPACE LINK EXTENSION— SERVICE MANAGEMENT—

## SPACE LINK PHYSICAL LAYER MANAGED OBJECT SPECIFICATION

**CCSDS 910.7-R-1**

**RED BOOK**

October 2001

# AUTHORITY

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This document has been approved for publication by the Management Council of the Consultative Committee for Space Data Systems (CCSDS) and represents the consensus technical agreement of the participating CCSDS Member Agencies. The procedure for review and authorization of CCSDS Recommendations is detailed in reference [1], and the record of Agency participation in the authorization of this document can be obtained from the CCSDS Secretariat at the address below.

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# FOREWORD

**(WHEN THIS RECOMMENDATION IS FINALIZED, IT WILL CONTAIN THE FOLLOWING FOREWORD)**

This document is a technical **Recommendation** for use in developing ground systems for space missions and has been prepared by the **Consultative Committee for Space Data Systems** (CCSDS).  The Space Link Physical Layer managed objects (MOs) described herein form a part of the Space Link Extension Service Management concepts intended for missions that are cross supported between Agencies of the CCSDS.

This **Recommendation** establishes the physical layer aspects of Service Management for the specification of data services that extend the space to ground communication services previously defined by CCSDS.  It allows implementing organizations within each Agency to proceed coherently with the development of compatible derived Standards for the ground systems that are within their cognizance.  Derived Agency Standards may implement only a subset of the optional features allowed by the **Recommendation** and may incorporate features not addressed by the **Recommendation**.

Through the process of normal evolution, it is expected that expansion, deletion or modification to this document may occur.  This Recommendation is therefore subject to CCSDS document management and change control procedures as defined in reference [E1].  Current versions of CCSDS documents are maintained at the CCSDS Web site:

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Questions relating to the contents or status of this document should be addressed to the CCSDS Secretariat at the address indicated on page i.

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# PREFACE

This document is a draft CCSDS Recommendation. Its 'Red Book' status indicates that the CCSDS believes the document to be technically mature and has released it for formal review by appropriate technical organizations. As such, its technical contents are not stable, and several iterations of it may occur in response to comments received during the review process.

Implementers are cautioned **not** to fabricate any final equipment in accordance with this document's technical content.

# DOCUMENT CONTROL

| Document | Title | Date | Status |
|---|---|---|---|
| CCSDS 910.7-R-1 | Space Link Extension—Service Management—Space Link Physical Layer Managed Object Specification | October 2001 | Original Issue |

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# 1 INTRODUCTION

## 1.1 PURPOSE OF THIS RECOMMENDATION

### 1.1.1 BASELINE AND REFERENCE FOR SLE SERVICE MANAGEMENT

This draft Recommendation specifies the managed objects that are used to configure, control, and monitor the space link physical layer functions of a Space Link Extension (SLE) Complex. The space link physical layer functions deal with the transmission of the data link layer data units across the physical medium that connects the communicating systems, which, in the case of SLE, are the Space Element (i.e., spacecraft) and the SLE Complex that terminates the space link on the ground side. The physical layer is responsible for transforming the bits of the data link layer into a form suitable for propagation across the medium (space), transmitting those transformed bits, receiving the transformed bits, and restoring their original (bit) form.

This draft Recommendation forms a part of the framework for the management of SLE services.

### 1.1.2 RELATION TO CROSS SUPPORT REFERENCE MODEL AND SLE SERVICE MANAGEMENT SPECIFICATION

a) The *Cross Support Reference Model* (reference [12]) provides the framework for definition of SLE Service specifications to be used in support of space missions. It defines functional and management components of the common characteristics of SLE Services, the template for SLE Service specifications, and the identification of the SLE transfer services.

b) The *Cross Support Reference Model* establishes a model for space mission data exchange. The space mission users and management are represented by the Mission Data Operations System (MDOS), which exchanges return and forward data with the Space Element (i.e., spacecraft) across a space link (e.g., a radio link). The SLE System transfers this application data using SLE transfer services. The SLE System consists of one or more SLE Complexes working cooperatively to connect the MDOS to its associated Space Element. In addition, the MDOS and the SLE Complex(es) exchange management data for the purpose of managing the SLE transfer services.

c) The *Space Link Extension – Service Management Specification* (reference [15], referred to as *Service Management*) complements SLE transfer service specifications developed within the framework of the *Cross Support Reference Model* (reference [12]). It identifies a number of managed objects that enable ground data systems to schedule, configure, operate, and monitor the communication across the space link, and the production and provision of SLE transfer services for a space mission.

d) This *Space Link Physical Layer Managed Object Specification* complements *Service Management* (reference [15]) by specifying the managed objects associated with

configuring, controlling, and monitoring the physical layer resources of the SLE Complex that are used to communicate with the Space Element across the space link.

## 1.2 SCOPE

*Service Management* (reference [15]) defines the overall framework for management of SLE services including the formal model for interactions between a spaceflight mission and an SLE service-providing complex, and the management operations that each can invoke on the other. *Service Management* also identifies an object-oriented way of defining the management aspects of the numerous functions of the SLE Complex by using a methodology that involves the specification of **managed objects** that embody all management aspects of the physical resources that they represent. Finally, *Service Management* specifies all of the managed objects associated with processing, storing, and transporting the CCSDS data units that are within the scope of the *Cross Support Reference Model* (reference [12]), and the valid ways in which these managed objects may be combined to effect SLE service management of all legitimate configurations of SLE Complexes.

*Service Management* explicitly *excludes* the definition of the managed objects associated with the physical layer of the communication system used for communication between an SLE Complex and the Space Element (i.e., spacecraft) of a spaceflight mission. However, the management framework has been explicitly designed to easily integrate such managed objects.

This draft Recommendation defines the managed objects that represent the functions of the space link physical layer. The methodology used in this draft Recommendation is the same as that used in *Service Management* and the management operations are the same as in *Service Management*.

At present, the physical layer interface across the space link involves modulating signals onto radio frequencies (RF). However, SLE does not constrain the physical layer to be limited to RF signals. The structure of this draft Recommendation is such that it is open to other transmission mechanisms (e.g., optical). If and when other types of physical layer mechanisms are standardized by CCSDS, the management of those mechanisms will be incorporated into this draft Recommendation.

## 1.3 APPLICABILITY

### 1.3.1 APPLICABILITY OF THIS DRAFT RECOMMENDATION

This draft Recommendation is applicable to systems that provide:

a) physical layer (e.g., radio) connectivity across a space link between the ground and spacecraft,

b) access to that space link via Space Link Extension transfer services, and

c) a management interface conformant to *Service Management* (reference [15]).

## 1.3.2 LIMIT OF APPLICABILITY

This draft Recommendation is not intended to be a specification for actual implementations of SLE systems.

In order to achieve compatibility, the structure and behavior of independent implementations of SLE managed objects must adhere to the formal specification contained in the *Space Link Physical Layer Formal Specification* (reference [13]). It complements this draft Recommendation and presents a precise formal specification of the structure of the SLE managed objects.

The Limits of Applicability listed in *Service Management* (reference [15]) also apply to this draft Recommendation.

## 1.4 RATIONALE

The primary goal of CCSDS is to increase the level of interoperability among Agencies. This draft Recommendation furthers that goal by establishing (in conjunction with the provisions of *Service Management,* reference [15]) the means to describe the management aspects of resources used to communicate across a space link between a mission spacecraft and a ground station such that mission management and ground station management may negotiate for, schedule, monitor, and control the operation of those resources in a standard way. Reference [11], *Cross Support Concept — Part 1: Space Link Extension Services* provides further discussion of the rationale for this draft Recommendation.

## 1.5 DOCUMENT STRUCTURE

### 1.5.1 ORGANIZATION

This draft Recommendation is organized as follows:

a) Section 1 provides purpose, scope, applicability and rationale of this draft Recommendation and identifies the conventions and references used throughout the draft Recommendation. This section also describes how this document is organized. A brief description is provided for each section and annex so that the reader will have an idea of where information can be found in the document. It also identifies terminology that is used in this document but is defined elsewhere.

b) Section 2 provides the context for reading this draft Recommendation by describing the relationship of the space link physical layer resources to the *Cross Support Reference Model* (reference [12]) general SLE managed objects structure. This section also describes the relationship of the managed objects defined in this draft recommendation to those defined in *Service Management* (reference [15]).

c) Section 3 identifies the inheritance hierarchy and containment relationships for the managed object defined in this draft Recommendation.

d) Section 4 specifies the space link physical layer managed object classes that are common to all SLE Complexes that provide physical layer interfaces with Mission spacecraft.

e) Section 5 specifies the managed object classes for space link physical layer resources conforming to the CCSDS Radio Frequency and Modulation Systems (CCSDS 401.0) Recommendation.

f) Annex A contains a list of acronyms.

## 1.5.2   SLE SERVICES DOCUMENTATION TREE

This draft Recommendation is based on the cross support view of the architectural model defined in the *Cross Support Reference Model* (reference [12]).  It expands the SLE managed object structure described in *Service Management* (reference [15]).

This draft Recommendation is part of a suite of documents specifying the SLE services.  The SLE document suite constitutes one of three types of Cross Support Services:

a) Part 1:  SLE Services;[1]

b) Part 2:  Ground Communications Services;

c) Part 3:  Ground Domain Services.

SLE documents that are directly associated with this document are listed here and are shown graphically in figure 1-1.

a) *Standard Terminology, Conventions and Methodology (TCM) for Defining Data Services*; a Report identifying the existing international standards for defining SLE data services.  (Reference [10]).

b) *Cross Support Concept – Part 1:  Space Link Extension Services*; a Report introducing the concepts of cross support and SLE services;  (Reference [11]).

c) *Cross Support Reference Model — Part 1:  Space Link Extension Services*; a Recommendation that defines the reference model which provides a common basis for coordinating the development of CCSDS cross support recommendations (Reference [12]).

d) *Space Link Extension – Service Management Specification* (reference [15]); a draft Recommendation that defines the structure of the SLE managed information by specifying the ServiceAgreement managed object and other contained managed objects.

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[1]CCSDS Panel 3 is, at the time of publication, working only on Part 1 for SLE Services.
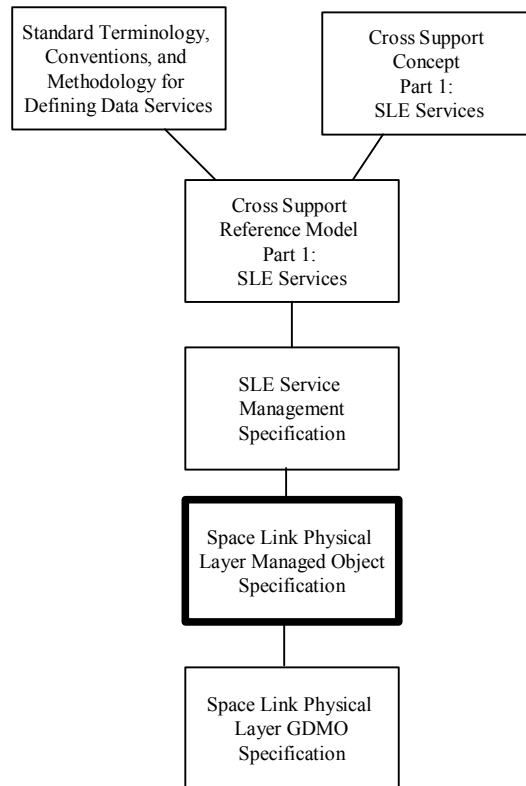
**Figure 1-1:  SLE Space Link Physical Layer Documentation**

e) *Space Link Physical Layer Managed Object Specification*; This Recommendation defines the attributes, notifications, and state transitions of physical layer managed objects which provide the detailed parameters needed by an SLE Complex for the production of SLE transfer services.

f) *SLE – Service Management – Space Link Physical Layer Formal Specification*; a Recommendation that provides the formal specification, utilizing GDMO description techniques, of the Space Link Physical Layer managed objects defined in (e) (Reference [13]).

NOTE  –  The SLE managed object classes are specified in the notation of the Guidelines for Description of Managed Objects (GDMO).  The GDMO notation is considered neutral to the implementation technology selected by individual CCSDS Agencies.  Technology platforms for SLE Complex Management Port include CMIS/CMIP, CORBA, DCE, DCOM, and SNMP.  Products exist which allow the automatic translation of interface definition languages.

### 1.5.3   HOW TO READ THIS DOCUMENT

This draft Recommendation is an extension of the concepts, overall architecture, and management framework specified in *Cross Support Concept* (reference [11]), *Cross Support Reference Model* (reference [12]), and *Service Management* (reference [15]), respectively. The reader should have a good understanding of the material in these other documents prior to reading this draft Recommendation. In particular, it is absolutely essential that the reader understand *Service Management* in order to understand this draft Recommendation.

### 1.6   DEFINITIONS

### 1.6.1   DEFINITIONS FROM CROSS SUPPORT REFERENCE MODEL

Section 3 of the *Cross Support Reference Model* (reference [12]) Recommendation defines the SLE System environment, data, and services.  It introduces terms and concepts in the SLE System.   The terms listed below are those needed for understanding of this draft Recommendation as a whole.   These terms are defined in the *Cross Support Reference Model*.

   a)   Space Mission Data System;

Space Element;

–   Space Link;

–   Ground Element;

–   Space Link Extension System;

–   Mission Data Operation System;

–   Mission User Entities;

–   SLE Utilization Management;

–   Space Link Data Unit;

–   Return Space Link Data Unit;

–   Forward Space Link Data Unit;

–   Space Link Data Channel;

–   Space Link Extension Service Data Unit;

–   Space Link Extension Data Channel;

–   SLE transfer service instance;

–   SLE service package.

## 1.6.2   NOMENCLATURE

The following conventions apply throughout this draft Recommendation:

a)  the words 'shall' and 'must' imply a binding and verifiable specification;

b)  the word 'should' implies an optional, but desirable, specification;

c)  the word 'may' implies an optional specification;

d)  the words 'is,' 'are,' and 'will' imply statements of fact.

## 1.6.3   CONVENTIONS

Style and format conventions used to prepare this document are identified in the *Cross Support Reference Model* Recommendation (reference [12]).   Drawing conventions are defined for representing types of (abstract) object and various instances of an object. Definitions are also provided for SLE Ports, Number of Ports for SLE Services, and SLE Object Refinement.

This draft Recommendation uses the terminology of OSI system management to define SLE Service Management.

This draft Recommendation uses the following typographical conventions:

**Table 1-1:  Typographic Conventions**

| FORMAT | MEANING |
|---|---|
| **Bold** | Names for attributes, constituents, actions, parameters, states or notifications (first use or definition) |
| *Italic* | Subsequent references to attributes, constituents, actions, parameters, states or notifications |
| 'Single quotes' | Values for attributes, constituents or parameters |
| ALL CAPS | Operations |

Managed object classes are identified by names starting with an uppercase letter. Instances of a managed object class are usually identified with the class name by lowering the first letter. For example, a virtualChannel managed object is an instance of the VirtualChannel managed object class.

An attribute of a dedicated managed object instance is identified by concatenating the attribute name to the managed object instance name, separated by a period, as in the following example: virtualChannel.vcId denotes the *vcId* attribute of a virtualChannel managed object.

## 1.7   REFERENCES

The following documents contain provisions, which, through reference in this text, constitute provisions of this draft Recommendation.  At the time of publication, the editions indicated were valid.  All documents are subject to revision and users of this draft Recommendation are encouraged to investigate the possibility of applying the most recent editions of the documents indicated below.  The CCSDS Secretariat maintains a register of currently valid CCSDS Recommendations.

[1]   *Procedures Manual for the Consultative Committee for Space Data Systems*.  CCSDS A00.0-Y-7.4.  Yellow Book.  Issue 67  Washington, DC:  CCSDS, January 2001.

[2]   *Packet Telemetry*.  Recommendation for Space Data Systems Standards.  CCSDS 102.0-B-5.  Blue Book.  Issue 5.  Washington, DC:  CCSDS, November 2000.

[3]   *Packet Telemetry Services*.  Draft Recommendation for Space Data Systems Standards. CCSDS 103.0-B-1.  Blue Book.  Issue 1.  Washington, DC:  CCSDS, May 1996.

[4]   *Telemetry Channel Coding*.  Recommendation for Space Data Systems Standards. CCSDS 101.0-B-4.  Blue Book.  Issue 4.  Washington, DC:  CCSDS, May 1999.

*Temporary Note For Red Book 1* − As of the Red −1 issue of the Space Link Physical Layer Managed Object Specification, Issue 5 of CCSDS 101.0 is in publication. It is the result of the acceptance of the CCSDS 101.0-P-4.1 Pink Sheets that were approved at the May 2001 Panel 1 meetings in Pasadena. It is expected that the Issue 5 Blue Book will be published by the time that that this Recommendation is approved, at which time this Temporary Note will be deleted.

[5]   *Advanced Orbiting Systems, Networks and Data Links: Architectural Specification*. Recommendation for Space Data Systems Standards.  CCSDS 701.0-B-2.  Blue Book. Issue 2.  Washington, DC:  CCSDS, November 1992.

[6]   *Telecommand Part 1 – Channel Service*.  Recommendation for Space Data Systems Standards.  CCSDS 201.0-B-3.  Blue Book.  Issue 3.  Washington, DC:  CCSDS, June 2000.

[7]   *Telecommand Part 2 – Data Routing Service*.  Recommendation for Space Data Systems Standards.  CCSDS 202.0-B-2.  Blue Book.  Issue 2.  Washington, DC: CCSDS, November 1992.

[8]   *Telecommand Part 3 – Data Management Service*.  Recommendation for Space Data Systems Standards.  CCSDS 203.0-B-1.  Blue Book.  Issue 1.  Washington, DC: CCSDS, January 1987.

[9]   *Radio Frequency and Modulation Systems – Part 1:  Earth Stations and Spacecraft*. Recommendation for Space Data Systems Standards.  CCSDS 401.0-B-4.  Blue Book. Issue 4.  Washington, DC:  CCSDS, May 2000.

[10]  *Standard Terminology, Conventions, and Methodology (TCM) for Defining Data Services*.  Report Concerning Space Data Systems Standards.  CCSDS 910.2-G-1. Green Book.  Issue 1.  Washington, DC:  CCSDS, November 1994.

[11] *Cross Support Concept – Part 1: Space Link Extension Services.* Report Concerning Space Data Systems Standards. CCSDS 910.3-G-1. Green Book. Issue 1. Washington, DC: CCSDS, May 1995.

[12] *Cross Support Reference Model – Part 1: Space Link Extension Services.* Recommendation for Space Data Systems Standards. CCSDS 910.4-B-1. Blue Book. Issue 1. Washington, DC: CCSDS, May 1996.

[13] *Space Link Extension – Service Management – Space Link Physical Layer Object Formal Specification.* CCSDS Technical Panel Draft. CCSDS 910.13-W-1. White Book. n.p., n.d..

[14] *Space Link Extension—Service Management—Implementation Mapping Rules.* CCSDS Technical Panel Draft, CCSDS 910.12-W. White Book. n.p., n.d..

[15] *Space Link Extension – Service Management Specification.* Draft Recommendation for Space Data Systems Standards. CCSDS 910.5-R-2. Red Book. Issue 2. Washington, DC: CCSDS, October 2001.

[16] *SLE Service Specifications.* This is a group of documents that are in various stages of production, which may include (but not be limited to):

|  |  |
|---|---|
| Return All Frames | Forward CLTU |
| Return Channel Frames | Forward TC Frames |
| Return Space Packets | Forward Space Packets |
| Return OCF |  |

[17] *Guidelines for the Definition of Managed Objects.* ISO/IEC 10165-4 (x.722). Geneva: ISO, 1992.

[18] *Unified Modeling Language Reference Manual (Addison-Wesley Object Technology Series).* James Rumbaugh, Grady Booch, and Ivar Jacobson. New York: Addison-Wesley, 1998.

## 2   OVERVIEW

### 2.1   GENERAL

This section provides an overview of the management of the Space Link Physical Layer. For context, a typical spaceflight mission environment is summarily described in terms of elements of the *Cross Support Reference Model* (reference [12]). This is followed by a description of the relationship of the space link physical layer to the functional groups of the *Cross Support Reference Model*. Finally, the management of space link physical layer resources is placed in the context of overall SLE service management.

### 2.2   SPACEFLIGHT MISSION ENVIRONMENT IN TERMS OF THE CROSS SUPPORT REFERENCE MODEL

This section summarizes at a high level the relationship between a spaceflight mission environment and the *Cross Support Reference Model*. Figure 2-1 illustrates an example system environment for the support of a spaceflight mission: a mission spacecraft, several ground stations, a mission control center, a payload data processing center, and a community of instrument users. There are of course, many variations of spaceflight mission environments; this particular example happens to be rather common, and is suitable for illustrating major aspects of SLE concepts and the *Cross Support Reference Model*.
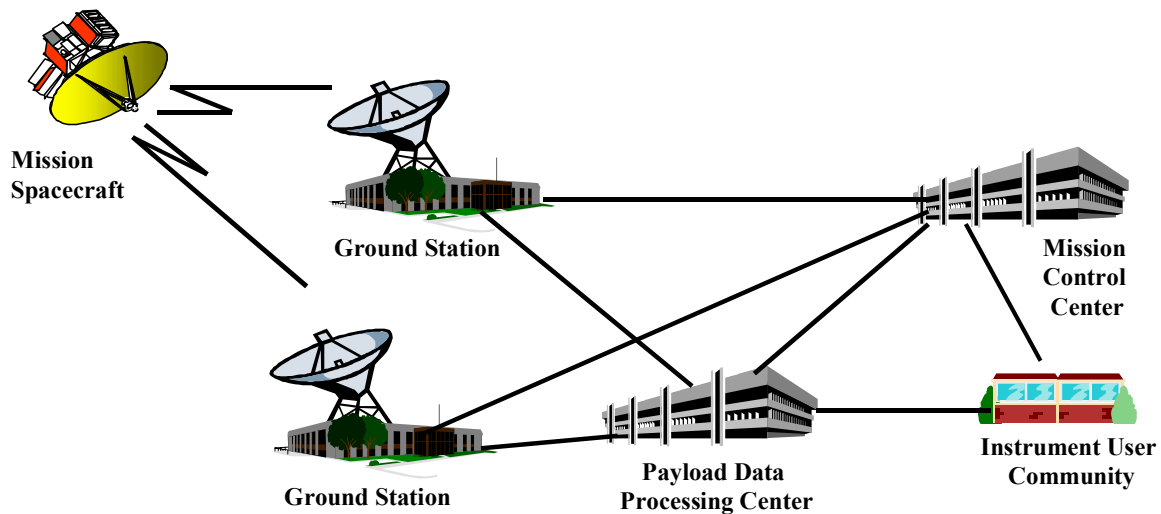


**Figure 2-1:  Example Spaceflight Mission Environment**

In accordance with the *Cross Support Reference Model*, the spaceflight mission system environment consists of a Space Element (the mission spacecraft) and a Ground Element (the ground stations, control center, payload center, and instrument user community).

The Ground Element is further segmented into the SLE System that supports the mission and the Mission Data Operation System (MDOS) for the system. The SLE System represents those functions, services, and management aspects of the Ground Element that are standardized in CCSDS SLE Recommendations. The MDOS represents the mission-specific aspects of the Ground Element. CCSDS does not standardize the functions of the MDOS other than to define the standard data transfer and management operations that the SLE System makes available to the MDOS.

For the purposes of this particular example, the ground stations and the payload data processing center are parts of the SLE System (i.e., they conform to CCSDS SLE standards), and the mission control center and the instrument user community comprise the MDOS.

The SLE System itself consists of one or more SLE Service Complexes (or just simply 'SLE Complexes'), each of which performs some or all of the standardized SLE functions and services needed to support the mission. The distinguishing characteristic of an SLE Complex is that it presents a single, unified management interface to the MDOS for the management of its resources.

For the purposes of this particular example, the ground stations and the payload data processing center are each a separate SLE Complex.

Figure 2-2 shows the components of the mission environment from figure 2-1 as they are formally represented in terms of the *Cross Support Reference Model*.
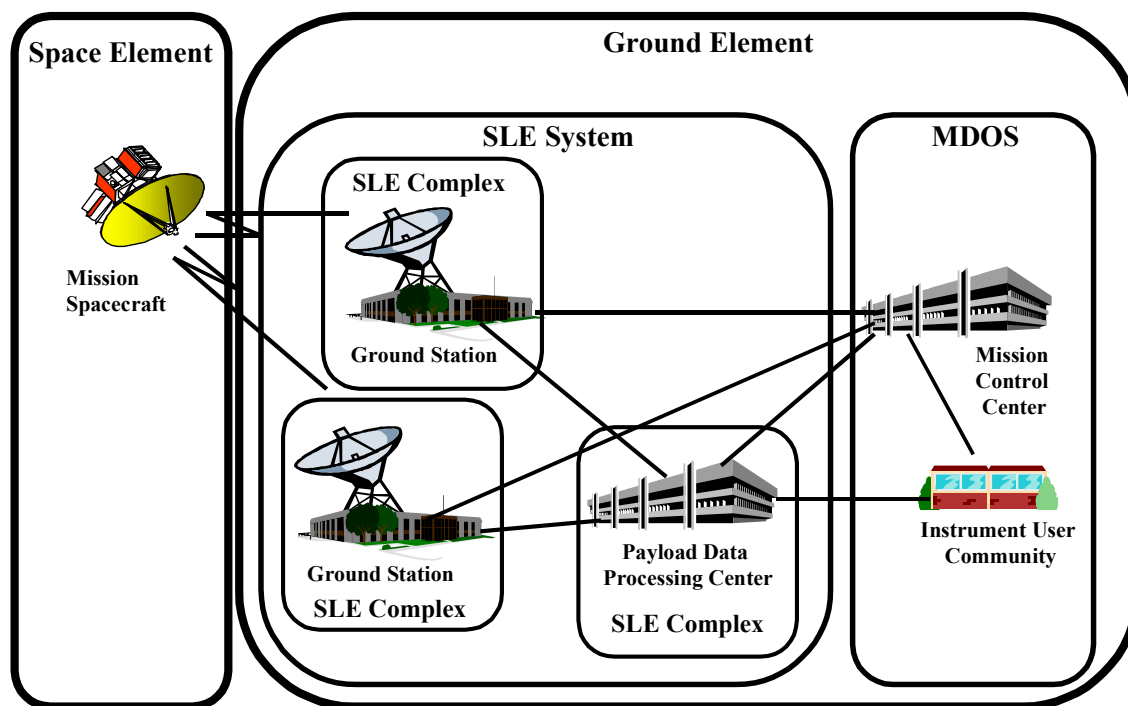


**Figure 2-2: Reference Model View of Example Spaceflight Mission Environment**

## 2.3 RELATIONSHIP OF THE SPACE LINK PHYSICAL LAYER TO THE CROSS SUPPORT REFERENCE MODEL

With respect to the *Cross Support Reference Model*, the space link physical layer functions are performed by:

    a) the Return Space Link Processing functional group for space links when Packet Telemetry and AOS protocols are used on the return link;

    b) the Forward TC Space Link Processing functional group when the Telecommand protocols are used on the forward link; and

    c) the Forward AOS Space Link Processing functional group when the AOS link protocols are used on the forward link.

Figure 2-3 illustrates the relationship between the space link physical layer resources and the other SLE resources within the Return Space Link Processing functional group. For the purposes of SLE management, the resources that perform the functions associated with the space link physical layer are divided into those associated with carrier processing and those associated with symbol stream processing. As shown in the figure, in general a single carrier may carry multiple symbol streams. Each return symbol stream carries a single stream of CCSDS-formatted transfer frames. These transfer frames are frame-synchronized and error-detected/corrected as part of the Return All Frames Production processing. These transfer frames may then be stored (for subsequent delivery via offline service), provided to users, and/or further processed to extract embedded data.
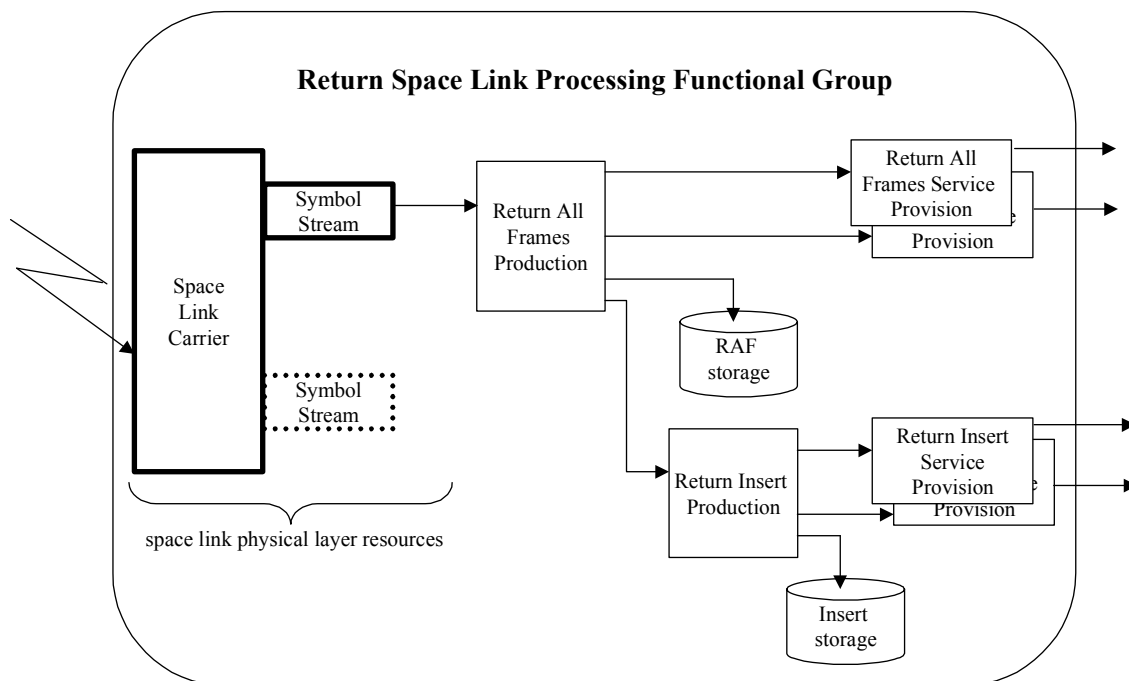


**Figure 2-3:    Space Link Physical Layer Resources in the Return Space Link Processing Functional Group**

Figure 2-4 illustrates the relationship between the space link physical layer resources and the other SLE resources within the Forward TC Space Link Processing functional group. As with figure 2-3, the space link physical layer resources are divided into carrier processing and symbol stream processing and in general a single carrier may carry multiple symbol streams. In the Forward TC Space Link Processing functional group, each forward symbol stream carries a single Telecommand session stream, which is formed by a TC Session Production resource that takes CCSDS Command Link Transmission Units (CLTUs) received from either an online CLTU service user or a CLTU storage resource.

NOTE –  Even though the services associated with the Forward AOS Space Link Processing functional group have not yet been developed, the relationship between the space link physical layer resources and the other SLE resources within that functional group would be essentially the same as with the Forward TC Space Link Processing functional group. That is, the space link physical layer resources would be divided into carrier processing and symbol stream processing. In general, a single carrier could carry multiple symbol streams and each forward symbol stream would carry a single stream of CCSDS link-layer data units.
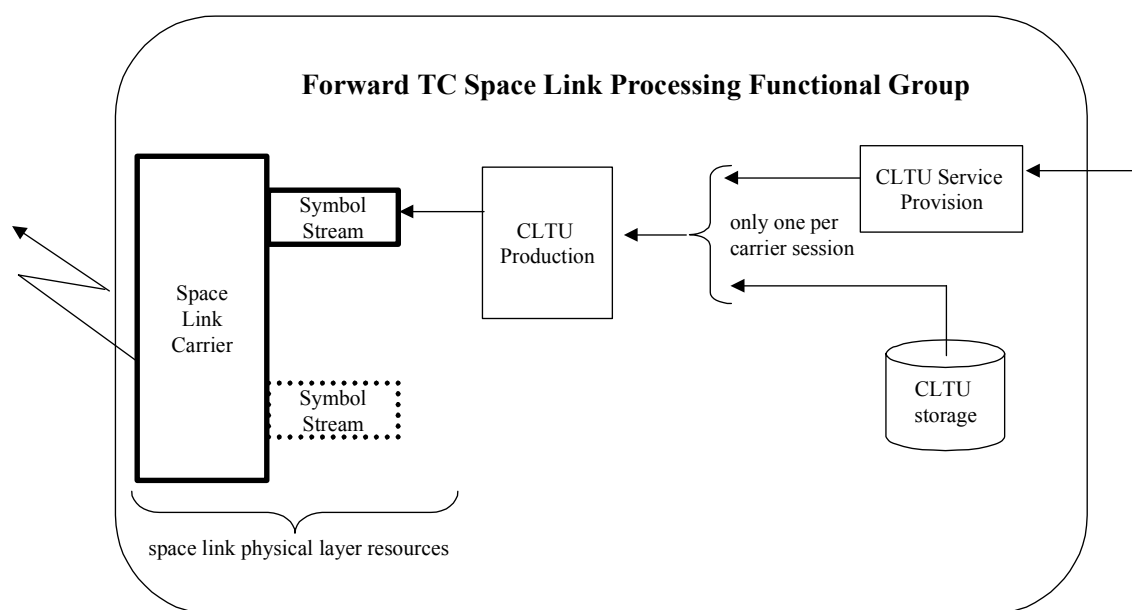


**Figure 2-4:**  **Space Link Physical Layer Resources in the Forward TC Space Link Processing Functional Group**

Although only one space link carrier resource is depicted in each of figures 2-3 and 2-4, a real SLE Complex (and real service agreements supported by that SLE Complex) may have multiple space link carriers, forward and/or return, operating in a single service package. Each of the space link carriers has its own **carrier session** which is the time period during which that carrier is operating. The various carrier sessions of a service package may start and stop at different times.

## 2.4 MANAGEMENT OF SPACE LINK PHYSICAL LAYER RESOURCES

### 2.4.1 OVERVIEW

The management aspects of space link physical layer resources are represented as managed objects, using the object modeling approach specified in *Service Management* (reference [15]). Use of space link physical layer managed objects in the negotiation, scheduling, controlling, and monitoring of SLE service production and provision permits SLE Utilization Management (UM) and SLE Complex Management (CM) to perform all of their SLE management interactions within the same management framework.

Figure 2-5 illustrates the relationships among space link physical layer managed objects. A general principle of SLE Service Management is that management information in the service agreement constitutes the bounds on resources that may be requested as part of any service package submitted under that service agreement. This principle applies to the management of space link physical layer resources. The service agreement-level management information is encapsulated in managed objects with names of the form '___Characteristics'. The service package-level management information is encapsulated in managed objects with names of the form '___Package'.

The SpaceLinkCarrierCharacteristics, SymbolStreamCharacteristics, SpaceLinkCarrier-Package and SymbolStreamPackage are abstract managed object classes which cannot be instantiated. Rather, derived classes must be created that correspond to real space link communications technologies. It is instances of these concrete-derived classes that are created and contained by the ServiceAgreement and ServicePackage managed objects. In the figure, the '<<xxx>>' notation means 'instance of concrete subclass derived from the xxx class'.

The following subsections more fully describe the service agreement-level managed objects, the service package-level managed objects and the relationships among them.
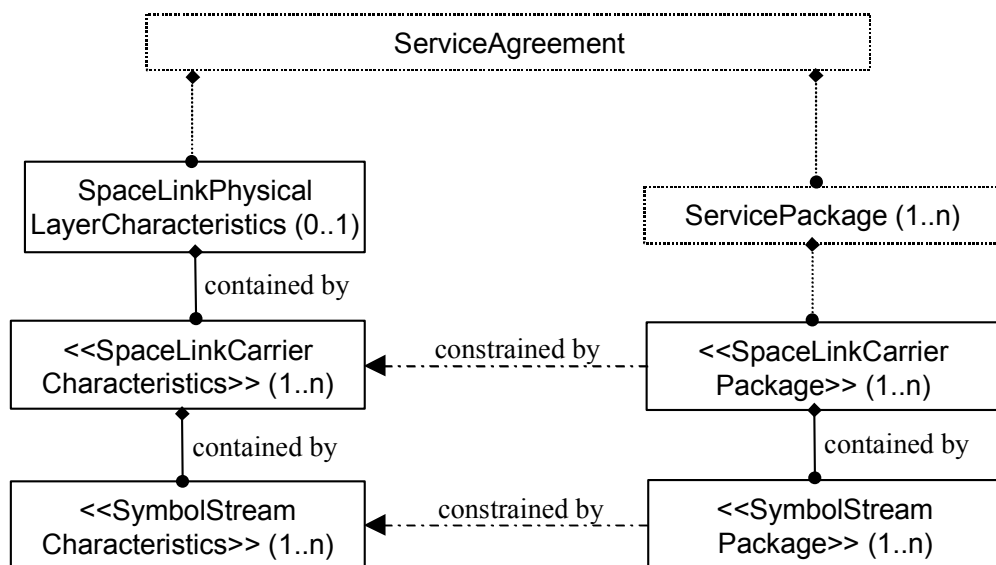
**Figure 2-5:  Relationships Among Space Link Physical Layer Managed Objects**

## 2.4.2   SERVICE AGREEMENT-LEVEL MANAGED OBJECTS

As described in 2.3, space link physical layer resources are modeled as two types of resource: a carrier resource type that embodies the functionality associated with the transmission of the data across the physical medium and a symbol stream resource type that embodies the functionality associated with the symbol stream or streams that are modulated onto a carrier. Depending upon the particular carrier technology used, a single carrier may carry one or more symbol streams. The managed objects representing the space link physical layer resources mirror the division of functionality according to carrier and symbol stream.

An instance of a subclass of the SpaceLinkCarrierCharacteristics managed object class embodies the long-term management information associated with supporting a single space link carrier. This includes such information as the maximum frequency that can be used on that carrier during the course of the service agreement, whether subcarriers may be used always, sometimes, or never, and what modulation types may be used during the course of the service agreement. Concrete subclasses of the SpaceLinkCarrierCharacteristics managed object class correspond to specific space link physical layer technologies and link 'directions' (forward and return).

An instance of a subclass of the SymbolStreamCharacteristics managed object class embodies the long-term management information associated with supporting a single symbol stream. This includes such information as the maximum symbol rate that can be used on that symbol stream during the course of the service agreement and what types (if any) of convolutional coding may be used always, sometimes, or never during the course of the service agreement. Concrete subclasses of the SymbolStreamCharacteristics managed object class correspond to specific space link physical layer technologies and link 'directions' (forward and return).

Subsection 3.1 identifies the concrete subclasses of the SpaceLinkCarrierCharacteristics and SymbolStreamCharacteristics classes that are defined in this specification.

Subsection 3.2 identifies the containment relationships among the ServiceAgreement managed object, the SpaceLinkCarrierCharacteristics-derived managed objects, and the SymbolStreamCharacteristics-derived managed objects that are defined in this specification. As shown in figure 3-1, the SpaceLinkCarrierCharacteristics-derived managed objects are not contained directly by the ServiceAgreement, but rather by a single SpaceLinkPhysicalLayerCharacteristics managed object, which itself is directly contained by the ServiceAgreement managed object. The SpaceLinkPhysicalLayerCharacteristics managed object serves no other purpose than to contain one or more SpaceLinkCarrierCharacteristics-derived managed objects and it exists only in service agreements for SLE Complexes that provide space link connectivity to the mission spacecraft. Each SpaceLinkCarrierCharacteristics-derived managed object contains one or more SymbolStreamCharacteristics-derived managed objects; the number depending upon the particular space link physical layer technology that is being employed.

Subsections 4.2, 4.3, and 4.4 specify the SpaceLinkPhysicalLayerCharacteristics, SpaceLinkCarrierCharacteristics, and SymbolStreamCharacteristics managed object classes, respectively. Subsequent subsections specify the derived subclasses of the SpaceLinkCarrierCharacteristics and SymbolStreamCharacteristics classes for specific space link physical layer technologies, with one subsection per technology.

## 2.4.3   SERVICE PACKAGE-LEVEL MANAGED OBJECTS

In each service package that implements a space link carrier session, managed objects must be instantiated to represent the carrier and symbol stream processing resources needed for that service package. As with the service agreement-level managed objects, the managed objects representing the space link physical layer resources at the service package level mirror the division of functionality according to carrier and symbol stream.

An instance of a subclass of the SpaceLinkCarrierPackage managed object class embodies the management information associated with supporting a single space link carrier during the course of a single carrier session. This includes such information as the initial frequency to be used on that carrier at the start of the carrier session, whether a subcarrier is to be used, and what modulation type to use during the course of the carrier session. Concrete subclasses of the SpaceLinkCarrierPackage managed object class correspond to specific space link physical layer technologies and link 'directions' (forward and return).

An instance of a subclass of the SymbolStreamPackage managed object class embodies the long-term management information associated with supporting a single symbol stream during the course of a single carrier session. This includes such information as the symbol rate to be used on that symbol stream during the course of the carrier session and what type (if any) of convolutional coding is to be used. Concrete subclasses of the SymbolStreamCharacteristics

managed object class correspond to specific space link physical layer technologies and link 'directions' (forward and return).

Subsection 3.1 identifies the concrete subclasses of the SpaceLinkCarrierPackage and SymbolStreamPackage classes that are defined in this specification.

Subsection 3.2 identifies the containment relationships among the ServicePackage managed object, the SpaceLinkCarrierPackage-derived managed objects, and the SymbolStreamPackage-derived managed objects that are defined in this specification. As shown in figure 3-1, the SpaceLinkCarrierPackage-derived managed objects are contained directly by the ServicePackage. Each SpaceLinkCarrierPackage-derived managed object contains one or more SymbolStreamPackage-derived managed objects, the number depending upon the particular space link physical layer technology that is being employed.

Subsections 4.5 and 4.6 specify the SpaceLinkCarrierPackage and SymbolStreamPackage managed object classes, respectively. Subsequent subsections specify the derived subclasses of the SpaceLinkCarrierPackage and SymbolStreamPackage classes for specific space link physical layer technologies with one subsection per technology.

## 2.4.4 RELATIONSHIP OF PACKAGE-LEVEL MANAGED OBJECTS TO AGREEMENT-LEVEL MANAGED OBJECTS

Each SpaceLinkCarrierPackage or SymbolStreamPackage managed object instance is constrained by a SpaceLinkCarrierCharacteristics or SymbolStreamCharacteristics managed object (see figure 2-5). When a SpaceLinkCarrierPackage or SymbolStreamPackage managed object instance is created by UM, the CREATE invocation identifies the correspsonding SpaceLinkCarrierCharacteristics or SymbolStreamCharacteristics managed object, respectively, and this relationship is captured in the attributes of the SpaceLinkCarrierPackage/SymbolStreamPackage managed object.

At validation time for the ServicePackage, the attributes of each contained SpaceLinkCarrierPackage and SymbolStreamPackage managed object are validated against the constraints specified in the corresponding SpaceLinkCarrierCharacteristics and SymbolStreamCharacteristics managed objects.

# 3  INHERITANCE AND CONTAINMENT OF SPACE LINK PHYSICAL LAYER MANAGED OBJECT CLASSES

## 3.1  MANAGED OBJECT INHERITANCE HIERARCHY

The SLE Managed Object Inheritance Hierarchy diagram in the SLE *S*ervice Management Concepts section of the SLE *S*ervice Management  Specification (reference [15]) illustrates the inheritance hierarchy for the managed objects defined in that draft Recommendation. Figure 3-1 illustrates the inheritance hierarchy that applies to the managed objects that are involved in the management of space link physical layer processing at both the service agreement and service package levels. As shown in the diagram, all SLE managed objects are derived from the SLEManagementEntity class, which is defined in *Service Management*.

NOTE –  As new concrete subclasses of the SpaceLinkCarrierCharacteristics, SpaceLinkCarrierPackage, SymbolStreamCharacteristics, and SymbolStream-Package abstract classes are defined, they will be added to the inheritance hierarchy diagram in figure 3-1.
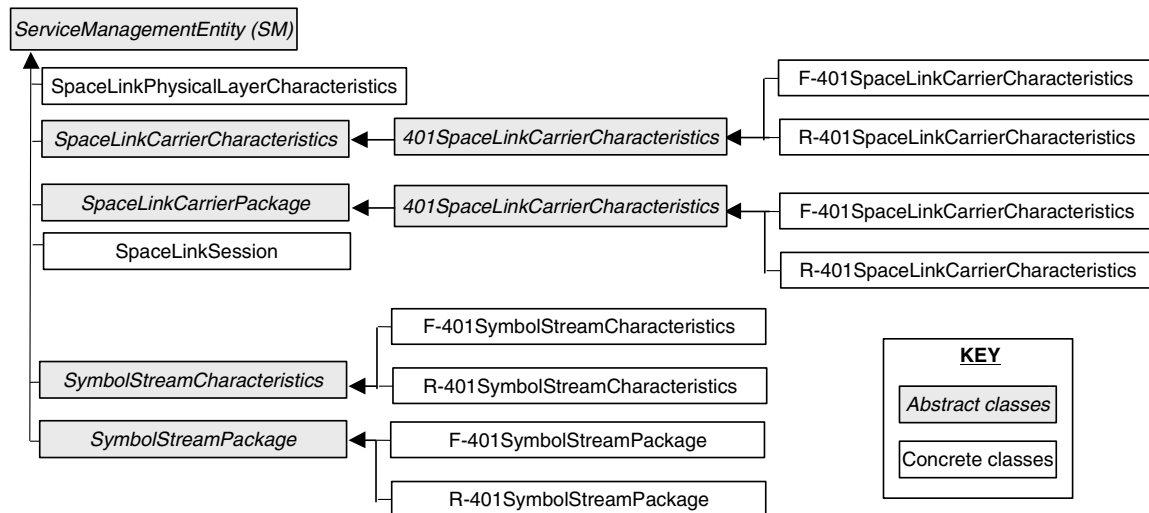


**Figure 3-1:  SLE Managed Object Inheritance Hierarchy for Space Link Physical Layer Managed Objects**

## 3.2 MANAGED OBJECT CONTAINMENT

Figure 3-2 depicts the containment relationships for the space link physical layer managed objects in the context of their immediate containment relationships with other managed objects. The ServiceAgreement, ServicePackage, F-tc-session-prod, and R-af-prod managed object classes are defined in *Service Management* (reference [15]). These externally defined managed objects are represented in the figure as dotted boxes. The F-pca-pdu-prod managed object is not currently fully defined, although a placeholder exists in *Service Management*. This status is represented in the figure by the use of italic font in the dotted line box.

NOTE – As new concrete subclasses of the SpaceLinkCarrierCharacteristics, SpaceLinkCarrierPackage, SymbolStreamCharacteristics, and SymbolStream-Package abstract classes are defined, they will be added to the containment list in figure 3-2.
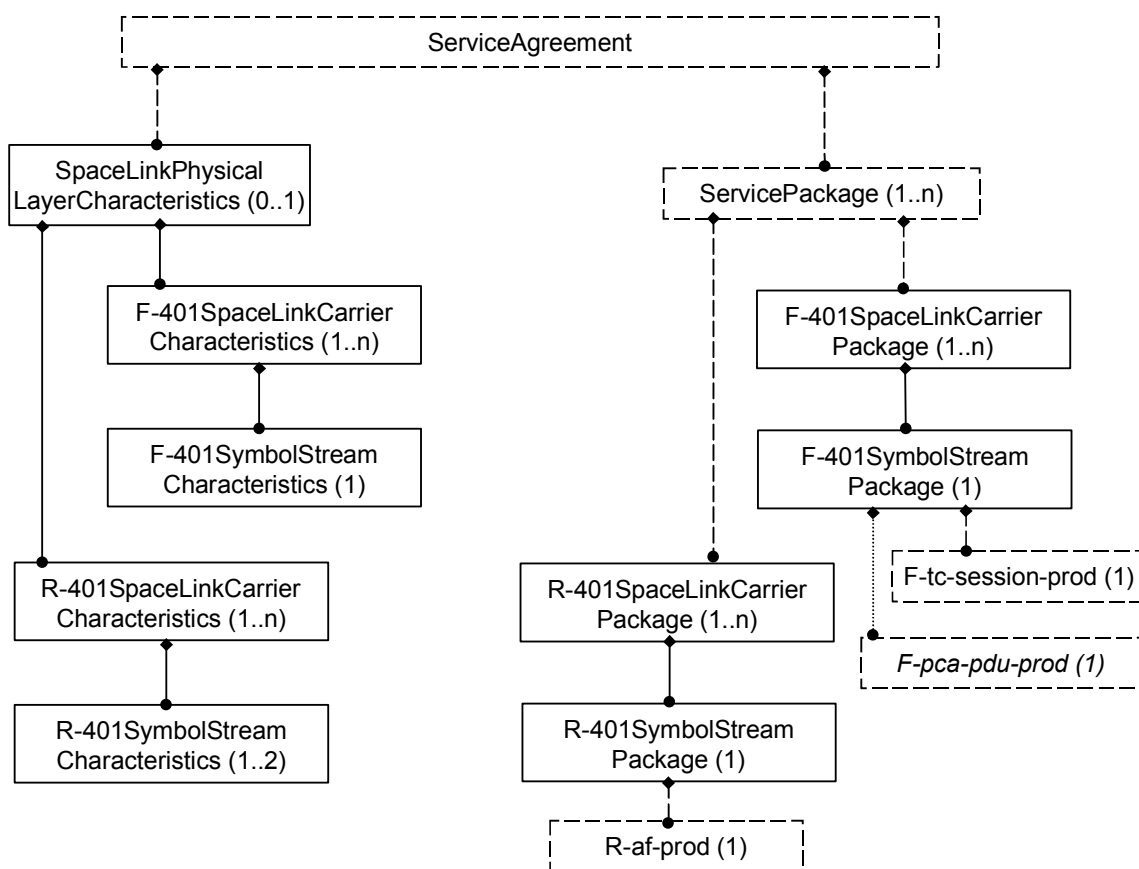


**Figure 3-2:     Containment Relationships for Space Link Physical Layer Managed Objects**

# 4 SPECIFICATION OF THE COMMON SPACE LINK PHYSICAL LAYER MANAGED OBJECT CLASSES

## 4.1 OVERVIEW

This section specifies the managed object classes that are common to all SLE Complexes that provide space link physical layer interfaces to mission spacecraft.

The SpaceLinkPhysicalLayerCharacteristics managed object is common to all service agreements that involve space link physical layer interfaces in that it contains the physical layer technology-specific managed objects associated with the overall Service Agreement.

The SpaceLinkCarrierCharacteristics, SymbolStreamCharacteristics, SpaceLinkCarrier-Package, and SymbolStreamPackage managed object classes are common in that they are the abstract classes from which all space link physical layer technology-specific subclasses are derived. The following subsections contain the specifications of technology-specific subclasses of these generic classes with one subsection for each technology.

## 4.2 SpaceLinkPhysicalLayerCharacteristics MANAGED OBJECT (MO) CLASS

### 4.2.1 PURPOSE

#### 4.2.1.1 General

  a) An instance of the SpaceLinkPhysicalLayerCharacteristics managed object class contains all of the constant, long-term radio frequency and modulation information for a spacecraft that complies with the pertinent CCSDS Recommendations.

  b) The SpaceLinkPhysicalLayerCharacteristics managed object does not specify this information directly, but serves as a container for other managed objects that specify the pertinent information. The radio-frequency and modulation information is provided by SLE Utilization Management during the creation of the managed objects. The information is constant throughout the life-time of a service agreement and builds background information for the provision of SLE services. The purpose for having the SpaceLinkPhysicalLayerCharacteristics managed objects as part of the Service Agreement is to establish a common knowledge of the space link between SLE Utilization Management and SLE Complex Management.

#### 4.2.1.2 Perception by SLE Utilization Management

  a) The SpaceLinkPhysicalLayerCharacteristics managed object and the contained managed objects are created as a result of the negotiations between SLE Utilization Management and SLE Complex Management to define the Service Agreement. These managed objects capture the the spacecraft's RF and modulation characteristics. Since the information therein is static, SLE Utilization Management supplies all managed

object attribute values during the creation and will never modify any attribute values. Therefore, the attributes are defined as read-only.

b) This perception by SLE Utilization Management is equal for all SpaceLinkPhysical-LayerCharacteristics managed objects. Therefore, the 'Perception by SLE Utilization Management' subsections in this document do not contain further information.

### 4.2.1.3 Perception by SLE Complex Management

a) SLE Complex Management is responsible for associating the managed objects contained by the SpaceLinkPhysicalLayerCharacteristics managed object with the suitable resources of the complex, i.e., it assures that the managed object attributes are associated with the corresponding parameters of the complex.

b) Since the information kept by the SpaceLinkPhysicalLayerCharacteristics managed object is constant, SLE Complex Management does not change any attribute values. There is also no need for SLE Complex Management to trigger any notifications in the managed objects.

c) This perception by SLE Complex Management is equal for the SpaceLinkPhysicalLayerCharacteristics managed object and all of its contained managed objects. Therefore, the 'Perception by SLE Complex Management' subsections in this document do not contain further information.

### 4.2.2   INHERITANCE—SpaceLinkPhysicalLayerCharacteristics MO CLASS

This managed object class is derived from and inherits the properties of the SLEManagementEntity managed object class.

### 4.2.3   OBJECTS CONTAINED—SpaceLinkPhysicalLayerCharacteristics MO CLASS

a) An instance of this concrete managed object class shall contain instances of the following classes:

1) zero, one, or multiple return-link-specific managed objects derived from the SpaceLinkCarrierCharacteristics managed object class. Each such managed object holds service agreement-level information about one of the radio frequency carriers of the spacecraft's return link.

2) zero, one, or multiple forward-link-specific managed objects derived from the SpaceLinkCarrierCharacteristics managed object class. Each such managed object holds service agreement-level information about one of the radio frequency carriers of the spacecraft's forward link.  The structure and behavior of the SpaceLinkCarrierCharacteristics managed object class is described in 4.2.

b) At least one instance of a managed object of one of the above-mentioned classes must be contained by the spaceLinkPhysicalLayerCharacteristics managed object in order for the containing serviceAgreement managed object to be permitted to enter the *agreed* state.

### 4.2.4   STATES—SpaceLinkPhysicalLayerCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no states are defined for this managed object class.

### 4.2.5   ATTRIBUTES—SpaceLinkPhysicalLayerCharacteristics MO CLASS

The values of all attributes defined below are negotiated and agreed upon before the managed object is exposed.

This managed object class has the following specific attributes:

a) **space-link-physical-layer-characteristics-mo-id.**  This is the naming attribute for this managed object class.

  1) Data type/values:  Character string.

  2) Modifications:  SET shall be disabled at all times.

b) **Attribute Value Summary**.  Refer to table 4-1.

**Table 4-1:  Attribute Value Summary—SpaceLinkPhysicalLayerCharacteristics Managed Object**

| Attribute | Inherited From | Initial Value | Specified In |
|---|---|---|---|
| space-link-physical-layer-characteristics-mo-id | — | — | CREATE.inv |
| read-me | SLEManagement Entity (reference [15]) | — | — |

### 4.2.6   ACTIONS—SpaceLinkPhysicalLayerCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no actions are defined for this managed object class or for its derived classes.

### 4.2.7 STATE-RELATED BEHAVIOR—SpaceLinkPhysicalLayerCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no state-related behaviors are defined for this managed object class.

### 4.2.8 NOTIFICATIONS—SpaceLinkPhysicalLayerCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no notifications are defined for this managed object class.

### 4.2.9 VALIDATION ASPECTS—SpaceLinkPhysicalLayerCharacteristics MO CLASS

There are no validation aspects for this managed object.  This managed object is created outside the scope of any Service Package, and therefore is not subject to the Service Package validation process.

## 4.3 SpaceLinkCarrierCharacteristics MANAGED OBJECT CLASS

### 4.3.1 PURPOSE

#### 4.3.1.1 General

a) The SpaceLinkCarrierCharacteristics managed object class is an abstract class that is the parent of all technology-specific forward and return space link carrier characteristics managed object classes.

b) An instance of a technology-specific concrete subclass of this class is used by SLE Utilization Management and SLE Complex Management to

1) select the space link physical layer technology that will be used to support the mission for the duration of the service agreement;

2) specify the bounds of the operational parameters of that technology that will apply to all subsequent service packages.

c) Managed objects of these derived classes, as opposed to the SpaceLinkCarrier-Characteristics class, are exposed at the management ports.

#### 4.3.1.2 Perception by SLE Utilization Management

No managed object of this class is exposed by an SLE Complex.

**4.3.1.3 Perception by SLE Complex Management**

No managed object of this class is exposed by an SLE Complex.

**4.3.2   INHERITANCE—SpaceLinkCarrierCharacteristics MO CLASS**

This managed object class is derived from and inherits the properties of the SLEManagementEntity managed object class.

**4.3.3   OBJECTS CONTAINED—SpaceLinkCarrierCharacteristics MO CLASS**

This managed object class is an abstract class; thus it cannot be instantiated and containment relationships do not apply.

**4.3.4   STATES—SpaceLinkCarrierCharacteristics MO CLASS**

Because this managed object class is used to construct the service agreement, no states are defined for this managed object class or for its derived classes.

**4.3.5   ATTRIBUTES—SpaceLinkCarrierCharacteristics MO CLASS**

The SpaceLinkCarrierCharacteristics managed object class has the following object-specific attributes:

a)  **carrier-use-options.** This attribute specifies the carrier usage that may be applied to the carrier during the lifetime of the service agreement.

   1)  Data type/values:

      i)   'remnant' – Remnant carrier (phase modulation);

      ii)  'suppressed'– suppressed carrier;

      iii) 'both' – Both are permitted; selection will be made on a service-package basis.

   2)  Modifications:  SET shall be disabled at all times.

b)  **max-frequency.** This attribute specifies the maximum nominal (not Doppler-corrected) carrier frequency (in kHz) that will be used during the lifetime of the service agreement. It is used for downlink as well as for uplink carriers.

   1)  Data type/values:  positive integer.

   2)  Modifications:  SET shall be disabled at all times.

c)  **subcarrier-use-options.** This attribute indicates whether a subcarrier may be used during the lifetime of the service agreement.

1) Data type/values:

    i) 'always used' – subcarrier is used in every service package;

    ii) 'never used' – subcarrier is never used in any service package;

    iii) 'deferred' – use of the subcarrier is specified on a service package basis.

2) Modifications: SET shall be disabled at all times.

3) Dependencies: If the value of the *carrier-use-options* attribute is 'supressed', the value of this attribute must be 'never used'.

d) **max-subcarrier-freq.** This attribute specifies the maximum subcarrier frequency (in kHz) that will be used during the lifetime of the service agreement. It is used for downlink as well as for uplink carriers.

1) Data type/values: Positive integer.

2) Modifications: SET shall be disabled at all times.

3) Dependencies: This attribute is meaningful only if the value of the *subcarrier-use-options* attribute is 'always used' or 'deferred'.

e) **Attribute Value Summary**. Refer to table 4-2.

**Table 4-2: Attribute Value Summary—SpaceLinkCarrierCharacteristics Managed Object**

| Attribute | Inherited From | Initial Value | Specified In |
|---|---|---|---|
| carrier-use-options | — | — | — |
| max-frequency | — | — | — |
| subcarrier-use-options | — | — | — |
| max-subcarrier-freq | — | — | — |
| read-me | SLEManagement Entity (reference [15]) | — | — |

### 4.3.6 ACTIONS—SpaceLinkCarrierCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no actions are defined for this managed object class or for its derived classes.

### 4.3.7 STATE-RELATED BEHAVIOR—SpaceLinkCarrierCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no state-related behaviors are defined for this managed object class or for its derived classes.

**4.3.8   NOTIFICATIONS—SpaceLinkCarrierCharacteristics MO CLASS**

Because this managed object class is used to construct the service agreement, no notifications are defined for this managed object class or for its derived classes.

**4.3.9   VALIDATION ASPECTS—SpaceLinkCarrierCharacteristics MO CLASS**

There are no validation aspects for the derived classes of this abstract managed object class. Instances of the derived classes are created outside the scope of any Service Package and therefore are not subject to the Service Package validation process.

**4.4   SymbolStreamCharacteristics MANAGED OBJECT CLASS**

**4.4.1   PURPOSE**

**4.4.1.1 General**

  a)  The SymbolStreamCharacteristics managed object class is an abstract class that is the parent of all symbol stream format-specific forward and return symbol stream characteristics managed object classes.

  b)  An instance of a symbol stream format-specific concrete subclass of this class is used by SLE Utilization Management and SLE Complex Management to

  1)  select the coding technology that will be used to support the mission for the duration of the service agreement;

  2)  specify the bounds of the operational parameters of that technology that will apply to all subsequent service packages.

  c)  Managed objects of these derived classes, as opposed to the SymbolStream-Characteristics class, are exposed at the management ports.

**4.4.1.2 Perception by SLE Utilization Management**

No managed object of this class is exposed by an SLE Complex.

**4.4.1.3 Perception by SLE Complex Management**

No managed object of this class is exposed by an SLE Complex.

**4.4.2   INHERITANCE—SymbolStreamCharacteristics MO CLASS**

This managed object class is derived from and inherits the properties of the SLEManagementEntity managed object class.

### 4.4.3 OBJECTS CONTAINED—SymbolStreamCharacteristics MO CLASS

This managed object class is an abstract class; thus it cannot be instantiated and containment relationships do not apply.

### 4.4.4 STATES—SymbolStreamCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no states are defined for this managed object class or for its derived classes.

### 4.4.5 ATTRIBUTES—SymbolStreamCharacteristics MO CLASS

This managed object class has the following specific attributes:

a) **max-symbol-rate.** This attribute specifies the maximum symbol rate (measured in kilosymbols/sec) to be expected on this symbol stream during the lifetime of the service agreement.

   1) Data type/values:  Integer.

   2) Modifications:  SET shall be disabled at all times.

   3) Dependencies:   If the value of the *subcarrier-use-options* attribute of the containing SpaceLinkCarrierCharacteristics-derived managed object has a value of 'always used' or 'deferred', the value of *max-symbol-rate* must be calculated by an integer division of the *max-subcarrier-freq* of the containing SpaceLink-CarrierCharacteristics-derived managed object.

   NOTE –   The bit rate is not equivalent to the symbol rate. The resulting bit rate depends on the coding scheme.

b) **Attribute Value Summary.**  Refer to table 4-3.

**Table 4-3:  Attribute Value Summary—SymbolStreamCharacteristics Managed Object**

| Attribute | Inherited From | Initial Value | Specified In |
|---|---|---|---|
| max-symbol-rate | — | — | — |
| read-me | SLEManagement Entity (reference [15]) | — | — |

### 4.4.6 ACTIONS—SymbolStreamCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no actions are defined for this managed object class or for its derived classes.

### 4.4.7 STATE-RELATED BEHAVIOR—SymbolStreamCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no state-related behaviors are defined for this managed object class or for its derived classes.

### 4.4.8 NOTIFICATIONS—SymbolStreamCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no notifications are defined for this managed object class or for its derived classes.

### 4.4.9 VALIDATION ASPECTS—SymbolStreamCharacteristics MO CLASS

There are no validation aspects for the derived classes of this abstract managed object class. Instances of the derived classes are created outside the scope of any Service Package and therefore are not subject to the Service Package validation process.

### 4.5 SpaceLinkCarrierPackage MANAGED OBJECT CLASS

### 4.5.1 PURPOSE

#### 4.5.1.1 Geneal

a) The SpaceLinkCarrierPackage managed object class is an abstract class that is the parent of all RF technology-specific forward and return space link carrier package managed object classes.

b) An instance of an RF technology-specific concrete subclass of this class is used by SLE Utilization Management and SLE Complex Management to specify the values of the operational parameters of that RF technology that apply to the service package, within the bounds specified in the corresponding SpaceLinkCarrierCharacteristics managed object.

c) Managed objects of these derived classes, as opposed to the SpaceLinkCarrierPackage class itself, are exposed at the management ports.

#### 4.5.1.2 Perception by SLE Utilization Management

No managed object of this class is exposed by an SLE Complex.

#### 4.5.1.3 Perception by SLE Complex Management

No managed object of this class is exposed by an SLE Complex.

### 4.5.2  INHERITANCE—SpaceLinkCarrierPackage MO CLASS

This managed object class is derived from and inherits the properties of the SLEManagementEntity managed object class.

### 4.5.3  OBJECTS CONTAINED—SpaceLinkCarrierPackage MO CLASS

This managed object class is an abstract class; thus it cannot be instantiated and containment relationships do not apply.

### 4.5.4  STATES—SpaceLinkCarrierPackage MO CLASS

a) In the definition phase, a spaceLinkCarrierPackage managed object shall exist in one of the following states:

1) **Waiting.**  The managed object is created and may be edited or submitted to the validation process.

2) **Under validation.** The servicePackage managed object is undergoing validation. The managed object is static until validation is complete.

3) **Validated.** The managed object is confirmed by the validation of the servicePackage managed object that contains it. All pertinent Complex internal resources are allocated to the managed object.

b) In the utilization phase, a spaceLinkCarrierPackage managed object shall exist in one of the following states:

1) **Configured.**  An association between the managed object and the resource has been established and the resource has been successfully configured according to the managed object's attribute values.

2) **Operational.**  The SpaceLinkCarrierPackage session has started and the space link communication has been established.

3) **Unavailable.**  Space link communication is not possible for Complex-internal reasons or due to faults on space link resources.

4) **Completed.** The SpaceLinkCarrierPackage session has ended. The Complex and space link resources have been released.

5) **Done.**  All contained managed objects have transitioned to *done*.

### 4.5.5  ATTRIBUTES—SpaceLinkCarrierPackage MO CLASS

This managed object class has the following specific attributes:

a) **corresponding-characteristics-mo**. This attribute identifies the SpaceLinkCarrier-Characteristics managed object that specifies the Service Agreement-level parameters that provide the context for this particular SpaceLinkCarrierPackage instance.

   1) Data type/values: Distinguished name (DN).

   2) Modifications: SET shall be enabled in the *waiting* state.

b) **carrier-start-time.** This identifies the start of the carrier for the service package.

   1) Data type/values: CCSDS time code.

   2) Modifications: SET shall be enabled in the *waiting* state.

c) **carrier-stop-time.** This identifies the end of the carrier for the service package.

   1) Data type/values: CCSDS time code.

   2) Modifications: SET shall be enabled in the *waiting* state.

d) **carrier-use.** This attribute specifies the carrier usage to be applied to the carrier during the service package.

   1) Data type/values:

      i) 'remnant' – Remnant carrier (phase modulation);

      ii) 'suppressed'– suppressed carrier.

   2) Modifications: SET shall be enabled in the *waiting* state.

   3) Dependencies: In an instance of a concrete subclass of 401SpaceLinkCarrier-Package, the value of the *carrier-use* attribute is constrained to be within the bounds of the value of the *carrier-use-options* attribute of the corresponding 401SpaceLinkCarrierCharacteristics-derived managed object.

e) **frequency.** This attribute specifies the range of nominal (not Doppler-corrected) carrier frequency (in kHz) to be used during the service package. It is used for downlink as well as for uplink carriers.

   1) Data type/values: Positive integer.

   2) Modifications: SET shall be enabled in the *waiting* state.

   3) Dependencies: In an instance of a concrete subclass of 401SpaceLinkCarrier-Package, the value of the *carrier-use* attribute is constrained to be within the bounds of the value of the *carrier-use-options* attribute of the corresponding 401SpaceLinkCarrierCharacteristics-derived managed object.

f) **subcarrier-use.** This attribute indicates whether or not a subcarrier is to be used during the service package.

    1) Data type/values:

       i) 'used' – subcarrier is used;

       ii) 'not used' – subcarrier is not used.

    2) Modifications: SET shall be enabled in the *waiting* state.

    3) Dependencies: If the value of the *carrier-use* attribute is 'supressed', the value of this attribute must be 'not used'.

g) **subcarrier-freq.** This attribute specifies the subcarrier frequency (in kHz) to be used during the service package. It is used for downlink as well as for uplink carriers.

    1) Data type/values: Positive integer.

    2) Modifications: SET shall be enabled in the *waiting* state.

    3) Dependencies:

       i) In an instance of a concrete subclass of 401SpaceLinkCarrierPackage, the value of the *subcarrier-freq* attribute is constrained to be within the bounds of the value of the *max-subcarrier-freq* attribute of the corresponding 401SpaceLinkCarrierCharacteristics-derived managed object.

       ii) This attribute is meaningful only if the value of the *subcarrier-use* attribute has the value 'used'.

h) **time-of-signal-initiation.** This attribute indicates the first time the carrier entered the state *operational*. When the managed object is in the *waiting*, *under validation*, *validated*, or *configured* state, the value shall be equal to the value of *carrier-start-time*. When the managed object is in the *operational*, *completed*, *unavailable*, or *done* state, the value shall be equal to the time that the carrier actually entered the *operational* state for the first time.

    1) Data type/values: CCSDS time code.

    2) Modifications:

       i) GET shall be enabled in all states;

       ii) SET shall be disabled in all states.

i) **operational-time**. The accumulated time (in seconds) that the managed object has been in the state *operational*.

    1) Data type/values: Integer.

    2) Modifications:

       i) GET shall be enabled in all states;

       ii) SET shall be disabled in all states.

j) **unavailable-time**. The accumulated time (in seconds) that the managed object has been in the state *unavailable*.

    1) Data type/values: Integer.

    2) Modifications:

        i) GET shall be enabled in all states;

        ii) SET shall be disabled in all states.

k) **Attribute Value Summary**.  Refer to table 4-4.

**Table 4-4:  Attribute Value Summary—SpaceLinkCarrierPackage Managed Object**

| Attribute | Inherited From | Initial Value | Specified In |
|---|---|---|---|
| corresponding-characteristics-mo | — | by UM | CREATE.inv |
| carrier-start-time | — | by UM | CREATE.inv |
| carrier-stop-time | — | by UM | CREATE.inv |
| carrier-use | — | by UM | CREATE.inv |
| frequency | — | by UM | CREATE.inv |
| subcarrier-use | — | by UM | CREATE.inv |
| subcarrier-freq | — | by UM | CREATE.inv |
| time of-signal-initiation | — | by CM | — |
| operational-time | — | by CM | — |
| unavailable-time | — | by CM | — |
| read-me | SLEManagement Entity (reference [15]) | by UM | CREATE.inv |

### 4.5.6   ACTIONS—SpaceLinkCarrierPackage MO CLASS

### 4.5.6.1 Abort Action

An *abort* action immediately stops carrier acquisition.

### 4.5.7    STATE-RELATED BEHAVIOR—SpaceLinkCarrierPackage MO CLASS

### 4.5.7.1 Overview

Figure 4-1 illustrates the SpaceLinkCarrierPackage state transition.
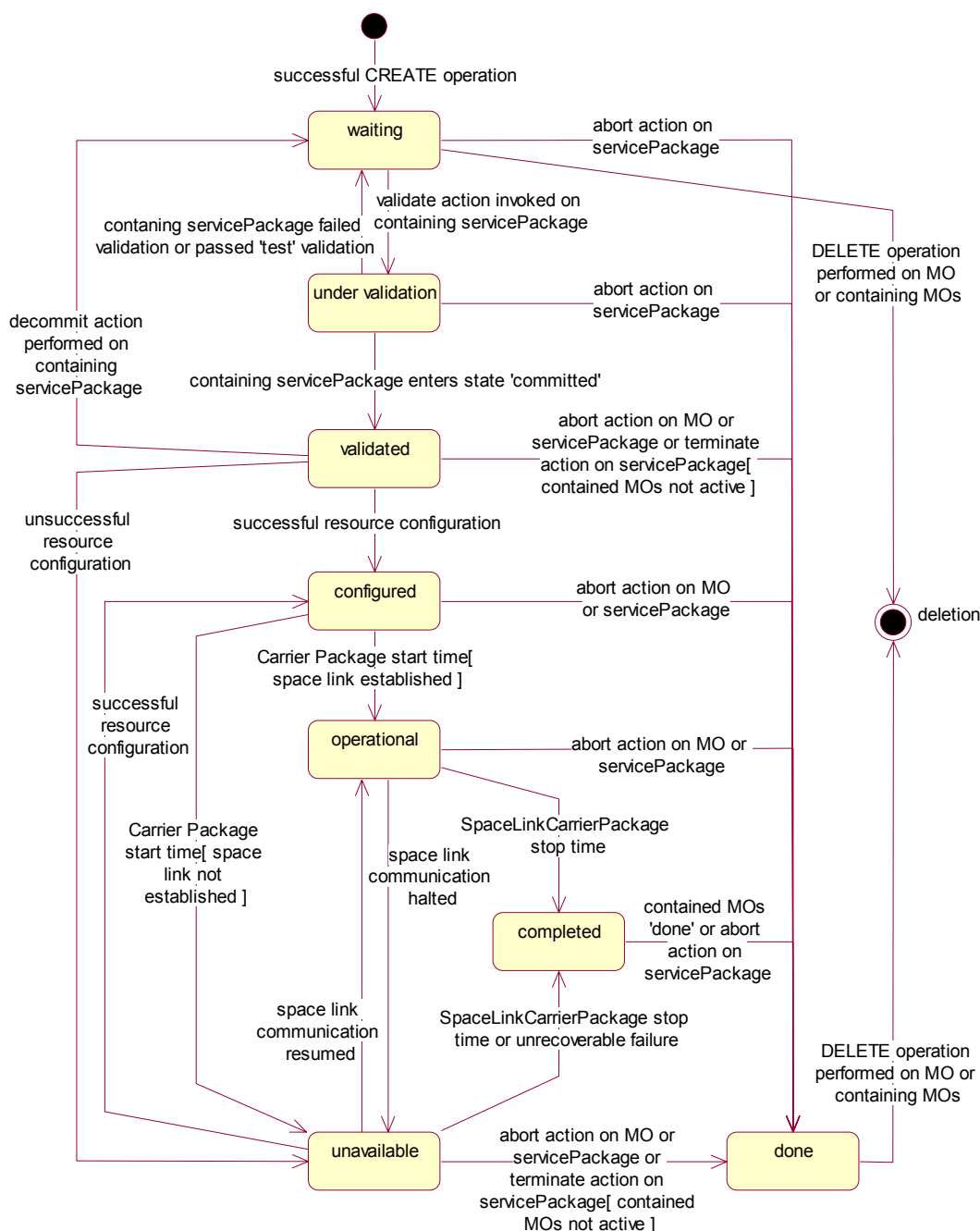


**Figure 4-1:  SpaceLinkCarrierPackage State Transition Diagram**

Since spaceLinkCarrierPackage managed objects are contained by servicePackage managed objects, the first two states of the definition phase, *waiting* and *under validation*, are the same as for the ServicePackage managed object class. Refer to the specification of the ServicePackage managed object class in *Service Management* for a discussion of definition phase states and state transitions associated with the servicePackage managed object and its contained objects. The specification of state-related behavior in this subsection begins with the *validated* state.

NOTES

1       GET operation requests are accepted in all states.

2       No general rules are defined in this subsection for the acceptance or rejection of SET operation requests. They are state- and attribute-dependent and hence are part of the attributes description.

### 4.5.7.2 VALIDATED State

**4.5.7.2.1**   Conditions for the spaceLinkCarrierPackage managed object entering the state *validated*:

If it passed the validation process and the servicePackage managed object that contains it is *committed*.

**4.5.7.2.2**   Actions and operations accepted and rejected by the spaceLinkCarrierPackage managed object in the state *validated*:

a)  Rejects a DELETE invocation;

b)  Rejects a CREATE invocation for contained managed objects;

c)  Accepts an *abort* action invocation.

**4.5.7.2.3**   Actions and operations on the containing managed objects that affect the spaceLinkCarrierPackage managed object when in the state validated:

a)  *decommit* action performed on the containing servicePackage managed object causes the spaceLinkCarrierPackage managed object to transition to state *waiting*;

b)  *terminate* action performed on the containing servicePackage managed object causes the spaceLinkCarrierPackage managed object to transition to state *done* if none of its contained managed objects is active (the states in which managed objects are considered 'active' are listed in *Service Management*, reference [15]);

c)  *abort* action performed on the containing servicePackage managed object causes a state transition to *done*.

### 4.5.7.3 CONFIGURED State

**4.5.7.3.1**    Conditions for the spaceLinkCarrierPackage managed object entering the state *configured*:

> If SLE Complex Management has established an association between the managed object and the resource and the resource has been successfully configured according to the managed object's attribute values.

**4.5.7.3.2**    Actions and operations accepted and rejected by the spaceLinkCarrierPackage managed object in the state *configured*:

a)  Rejects a DELETE invocation;

b)  Rejects a CREATE invocation for contained managed objects;

c)  Accepts an *abort* action invocation.

**4.5.7.3.3**    Actions and operations on the containing managed objects that affect the spaceLinkCarrierPackage managed object when in the state *configured*:

> *abort* action performed on the containing servicePackage managed object causes a state transition to *done*.

### 4.5.7.4 OPERATIONAL State

**4.5.7.4.1**    When in the state *operational*, the spaceLinkCarrierPackage managed object enables the space link physical layer resource to radiate a signal to the spacecraft (if the resource provides a forward physical channel) or to receive a signal from the spacecraft (if the resource provides a return physical channel).

**4.5.7.4.2**    Conditions for the spaceLinkCarrierPackage managed object entering the state *operational*:

a)  At SpaceLinkCarrierPackage start time, if SLE Complex Management has established space link communication;

b)  If space link communication is resumed when spaceLinkCarrierPackage managed object is in state *unavailable*.

**4.5.7.4.3**    Actions and operations accepted and rejected by the spaceLinkCarrierPackage managed object in the state *operational*:

a)  Rejects a DELETE invocation;

b)  Rejects a CREATE invocation for contained managed objects;

c)  Accepts an *abort* action invocation.

**4.5.7.4.4**   Actions and operations on the containing managed objects that affect the spaceLinkCarrierPackage managed object when in the state *operational*:

> *abort* action performed on the containing servicePackage managed object causes a state transition to *done*.

## 4.5.7.5 UNAVAILABLE State

**4.5.7.5.1**   When in the state *unavailable*, the spaceLinkCarrierPackage managed object waits for the space link communication to be re-established.

**4.5.7.5.2**   Conditions for the spaceLinkCarrierPackage managed object entering the state *unavailable*:

a) If managed object fails to establish association with space link resources or fails to configure space link resources;

b) If space link communication fails to be established or is halted (e.g. if the respective space link acquisition resource is defective and is unable to perform the specific operations).

**4.5.7.5.3**   Actions and operations accepted and rejected by the spaceLinkCarrierPackage managed object in the state *unavailable*:

a) Rejects a DELETE invocation;

b) Rejects a CREATE invocation for contained managed objects;

c) Accepts an *abort* action invocation.

**4.5.7.5.4**   Actions and operations on the containing managed objects that affect the spaceLinkCarrierPackage managed object when in the state *unavailable*:

a) *terminate* action performed on the containing servicePackage managed object causes the spaceLinkCarrierPackage managed object to transition to state *done* if none of its contained managed objects is active (the states in which managed objects are considered 'active' are listed in *Service Management*, reference [15]);

b) *abort* action performed on the containing servicePackage managed object causes a state transition to *done*.

## 4.5.7.6 COMPLETED State

**4.5.7.6.1**   When the state *completed* is entered, the spaceLinkCarrierPackage managed object is dissociated from its space link resources.

**4.5.7.6.2**   Conditions for the spaceLinkCarrierPackage managed object entering the state *completed*:

a) At SpaceLinkCarrierPackage stop time;

b) If recovery from corruption cannot be achieved.

**4.5.7.6.3**  Actions and operations accepted and rejected by the spaceLinkCarrierPackage managed object in the state *completed*:

a) Rejects a DELETE invocation;

b) Rejects a CREATE invocation for contained managed objects;

c) Rejects an *abort* action invocation.

**4.5.7.6.4**  Actions and operations on the containing managed objects that affect the spaceLinkCarrierPackage managed object when in the state *completed*:

> *abort* action performed on the containing servicePackage managed object causes a state transition to *done*.

### 4.5.7.7 DONE State

**4.5.7.7.1**  Conditions for the spaceLinkCarrierPackage managed object entering the state *done*:

a) If all of contained managed object have entered state *done*, when managed object is in state *completed*;

b) If a *terminate* action is performed on the containing servicePackage managed object when the spaceLinkCarrierPackage managed object is in state *validated* or *unavailable* and none of the contained managed objects is active (the states in which managed objects are considered 'active' are listed in *Service Management*, reference [15]);

c) If an *abort* action is performed either on the managed object or on the containing servicePackage managed object.

**4.5.7.7.2**  Actions and operations accepted and rejected by the spaceLinkCarrierPackage managed object in the state *done*:

a) Accepts a DELETE invocation;

b) Rejects a CREATE invocation for contained managed objects;

c) Rejects an *abort* action invocation.

**4.5.7.7.3**  Actions and operations on the containing managed objects that affect the spaceLinkCarrierPackage managed object when in the state *done*:

> DELETE operation performed on the containing servicePackage managed object causes the spaceLinkCarrierPackage managed object to be deleted.

### 4.5.8 NOTIFICATIONS—SpaceLinkCarrierPackage MO CLASS

This managed object issues the following state transition notifications:

a) **Start of carrier session.** This indicates that the managed object has transitioned from the state *configured* to *operational*.

b) **End of carrier session.** This indicates that the managed object has transitioned from the state *operational* to *completed*.

c) **Signal initiation occurred**. This indicates that the carrier has been modulated with a user signal for the first time during this carrier session.

d) **Carrier unavailable.** This indicates that the managed object has transitioned from the state *configured* to *unavailable.*

e) **Space link communication halted**. This indicates that the managed object has transitioned from the state *operational* to *unavailable*. A *space link communication halted* notification contains the following additional information:

> **Reason for interruption** (e.g., failure to successfully configure resources, unexpected LOS, equipment defect). This value is implementation-specific within a specific Complex. The value is provided by SLE Complex Management. It is a character string.

f) **Carrier operational.** This indicates that the managed object has transitioned from the state *unavailable* to *operational*.

g) **Unrecoverable failure.** This indicates that the managed object has transitioned from the state *unavailable* to *done* because of an unrecoverable error.

h) **Terminated**. This indicates that the managed object has transitioned to the state *done* due to a *terminate* action on the containing servicePackage managed object.

i) **Aborted.** This indicates that the managed object has transitioned to the state *done* due to an *abort* action on the containing servicePackage managed object.


### 4.5.9 VALIDATION ASPECTS—SpaceLinkCarrierPackage MO CLASS

No specific validation aspects are defined for this managed object class. However, validation aspects may be specified for the subclasses of this class.

## 4.6   SymbolStreamPackage MANAGED OBJECT CLASS

### 4.6.1   PURPOSE

**4.6.1.1 General**

a)  The SymbolStreamPackage managed object class is an abstract class that is the parent of all symbol stream format-specific forward and return symbol stream package managed object classes.

b)  An instance of a symbol stream-specific concrete subclass of this class is used by SLE Utilization Management and SLE Complex Management to specify the values of the operational parameters of that RF technology that apply to the service package, within the bounds specified in the corresponding SymbolStreamCharacteristics-derived managed object.

c)  Managed objects of these derived classes, as opposed to the SymbolStreamPackage class itself, are exposed at the management ports.

**4.6.1.2 Perception by SLE Utilization Management**

No managed object of this class is exposed by an SLE Complex.

**4.6.1.3 Perception by SLE Complex Management**

No managed object of this class is exposed by an SLE Complex.

### 4.6.2   INHERITANCE—SymbolStreamPackage MO CLASS

This managed object class is derived from and inherits the properties of the SLEManagementEntity managed object class.

### 4.6.3   OBJECTS CONTAINED—SymbolStreamPackage MO CLASS

This managed object class is an abstract class; thus it cannot be instantiated and containment relationships do not apply.

### 4.6.4   STATES—SymbolStreamPackage MO CLASS

No specific states are defined for this managed object class.  However, states may be specified for the subclasses of this class.

### 4.6.5 ATTRIBUTES—SymbolStreamPackage MO CLASS

This managed object class has the following specific attributes:

a) **corresponding-characteristics-mo**. This attribute identifies the SymbolStream-Characteristics managed object that specifies the Service Agreement-level parameters that provide the context for this particular SymbolStreamPackage instance.

    1) Data type/values: DN.

    2) Modifications: SET shall be enabled in the *waiting* state.

b) **symbol-rate.** This attribute specifies the symbol rate (in kilosymbols/sec) on this symbol stream during the lifetime of the space link session.

NOTE  –  The bit rate is not equivalent to the symbol rate. The resulting bit rate depends on the coding scheme.

    1) Data type/values: Integer.

    2) Modifications: SET shall be enabled in the *waiting* state.

    4) Dependencies: If the value of the *subcarrier-use* attribute of the containing SpaceLinkCarrierPackage-derived managed object has a value of 'used', the value of *symbol-rate* must be calculated by an integer division of the *subcarrier-freq* of the containing SpaceLinkCarrierPackage-derived managed object.

c) **Attribute Value Summary**. Refer to table 4-5.

**Table 4-5:  Attribute Value Summary— SymbolStreamPackage Managed Object**

| Attribute | Inherited From | Initial Value | Specified In |
|---|---|---|---|
| corresponding-characteristics-mo | — | by UM | CREATE.inv |
| symbol-rate | — | by UM | CREATE.inv |
| read-me | SLEManagement Entity (reference [15]) | by UM | CREATE.inv |

### 4.6.6 ACTIONS—SymbolStreamPackage MO CLASS

No specific actions are defined for this managed object class. However, actions may be specified for the subclasses of this class.

### 4.6.7 STATE-RELATED BEHAVIOR—SymbolStreamPackage MO CLASS

No class-specific state-related behavior is specified for this class.

**4.6.8   NOTIFICATIONS—SymbolStreamPackage MO CLASS**

No class-specific notifications specified for this class. However, notifications may be specified for the subclasses of this class.

**4.6.9   VALIDATION ASPECTS—SymbolStreamPackage MO CLASS**

No specific validation aspects are specified for this managed object class. However, validation aspects may be specified for the subclasses of this class.

# 5   SPECIFICATION OF PHYSICAL LAYER MANAGED OBJECT CLASSES FOR SPACE LINK COMMUNICATION SYSTEMS CONFORMING TO THE CCSDS 401 RECOMMENDATION

## 5.1   401SpaceLinkCarrierCharacteristics MANAGED OBJECT CLASS

### 5.1.1   PURPOSE

The 401SpaceLinkCarrierCharacteristics managed object class is an abstract class that specifies the long-term, service agreement-level constraints and options pertaining to the physical layer characteristics of a space link communication system that conforms to CCSDS 401, *Radio Frequency and Modulation Systems* (reference [9]). These attributes are inherited by the two concrete subclasses of this class, F-401SpaceLinkCarrierCharacteristics and R-401SpaceLinkCarrierCharacteristics.

### 5.1.2   INHERITANCE—401SpaceLinkCarrierCharacteristics MO CLASS

This managed object class is derived from and inherits the properties of the SpaceLinkCarrierCharacteristics managed object class.

### 5.1.3   OBJECTS CONTAINED—401SpaceLinkCarrierCharacteristics MO CLASS

This managed object class is an abstract class; thus it cannot be instantiated and containment relationships do not apply.

### 5.1.4   STATES—401SpaceLinkCarrierCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no states are defined for this managed object class or for its derived classes.

### 5.1.5   ATTRIBUTES—401SpaceLinkCarrierCharacteristics MO CLASS

This managed object class has the following specific attributes:

a)   **waveform-options.** This attribute specifies the set of waveforms that may be used on the carrier during the lifetime of the service agreement.

   1)   Data type/values:  Set of one or more of the following members:

      i)   'NRZ-L' – no return to zero-level;

      ii)   'NRZ-M' – no return to zero-mark;

      iii)   'SP-L' – split phase level.

2) Modifications: SET shall be disabled at all times.

b) **modulation-index-range.** This attribute specifies the range on the angle by which the RF carrier is phase shifted with respect to the un-modulated RF carrier, expressed in milli-radians ($10^{-3}$ rad). This range will apply for the duration of the service agreement.

   1) Data type/values:  Pair of positive integers, where the first integer is the lower bound and the second is the upper bound.

   2) Modifications:  SET shall be disabled at all times.

   3) Dependencies:   This attribute is meaningful only if the value of the *carrier-use-options* attribute is 'remnant'.

c) **polarization-options.** This attribute indicates the set of nominal polarization of the RF carrier that will be available during the lifetime of the service agreement.

NOTE  –  This attribute is irrelevant for the return link as long as a ground station supports diversity combination.

   1) Data type/values: Set of one or more of the following members:

      i)  'RHC' – right handed circular;

      ii) 'LHC' – left handed circular.

   2) Modifications: SET shall be disabled at all times.

b) **subcarrier-wave-options.** This attribute specifies the subcarrier waveforms that will be used during the lifetime of the service agreement.

   1) Data type/values:

      i)  'sine only' – sine wave only;

      ii) 'square only' – square wave only;

      iii) 'deferred' – both sine and square waves are permitted and the selection is made on a service package basis.

   2) Modifications: SET shall be disabled at all times.

   3) Dependencies:  This attribute is meaningful only if the value of the *subcarrier-use-options* attribute is 'always used' or 'deferred'.

c) **Attribute Value Summary**.  Refer to table 5-1.

**Table 5-1:   Attribute Value Summary—401SpaceLinkCarrierCharacteristics Managed Object**

| Attribute | Inherited From | Initial Value | Specified In |
|---|---|---|---|
| waveform-options | — | — | — |
| modulation-index-range | — | — | — |
| polarization-options | — | — | — |
| subcarrier-wave-options | — | — | — |
| carrier-use-options | SpaceLinkCarrier Characteristics (4.3) | — | — |
| max-frequency | SpaceLinkCarrier Characteristics (4.3) | — | — |
| subcarrier-use-options | SpaceLinkCarrier Characteristics (4.3) | — | — |
| max-subcarrier-freq | SpaceLinkCarrier Characteristics (4.3) | — | — |
| read-me | SLEManagement Entity (reference [15]) | — | — |

### 5.1.6   ACTIONS—401SpaceLinkCarrierCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no actions are defined for this managed object class or for its derived classes.

### 5.1.7   STATE-RELATED BEHAVIOR—401SpaceLinkCarrierCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no state-related behaviors are defined for this managed object class or for its derived classes.

### 5.1.8   NOTIFICATIONS—401SpaceLinkCarrierCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no notifications are defined for this managed object class or for its derived classes.

### 5.1.9   VALIDATION ASPECTS—401SpaceLinkCarrierCharacteristics MO CLASS

There are no validation aspects for the derived classes of this abstract managed object class. Instances of the derived classes are created outside the scope of any Service Package, and therefore are not subject to the Service Package validation process.

**5.2 R-401SpaceLinkCarrierCharacteristics MANAGED OBJECT CLASS**

**5.2.1   PURPOSE**

The R-401SpaceLinkCarrierCharacteristics managed object class is a concrete class that specifies the long-term service agreement-level constraints and options pertaining to the RF and modulation characteristics of the return link of a space link communication system that conforms to *CCSDS 401, Radio Frequency and Modulation Systems* (reference [9]).

**5.2.2   INHERITANCE—R-401SpaceLinkCarrierCharacteristics MO CLASS**

This managed object class is derived from and inherits the properties of the 401SpaceLinkCarrierCharacteristics managed object class.

**5.2.3   OBJECTS CONTAINED—R-401SpaceLinkCarrierCharacteristics MO CLASS**

An R-401SpaceLinkCarrierCharacteristics managed object contains one or two R-401SymbolStreamCharacteristics managed object(s), which hold(s) the information about the symbol stream(s) of the return link.   The structure and behavior of the R-401SymbolStreamCharacteristics managed object class is described in 5.4.

**5.2.4   STATES—R-401SpaceLinkCarrierCharacteristics MO CLASS**

Because this managed object class is used to construct the service agreement, no states are defined for this managed object class.

**5.2.5   ATTRIBUTES—R-401SpaceLinkCarrierCharacteristics MO CLASS**

This managed object class has the following specific attributes:

   a)  **r-401-carrier-char-mo-id.**  This is the naming attribute for this managed object class. It is used to construct the DN.

   1)  Data type/values: Character string.

   2)  Modifications:  SET shall be disabled at all times.

   b)  **modulation-type-options.** This attribute indicates the set of modulation types that will be available for the RF carrier during the lifetime of the service agreement.

   1)  Data type/values:  Set of one or more of the following members:

   i)   'BPSK' – Binary Phase Shift Key;

   ii)  'QPSK' – Quaternary Phase Shift Key;

iii) 'UQPSK' – Unbalanced Quaternary Shift Phase Key;

iv) 'OQPSK' – Offset Quaternary Shift Phase Key.

2) Modifications:  SET shall be disabled at all times.

3) Dependencies:  If the value of the *carrier-use-options* attribute is 'remnant', the value of this attribute shall have only one member, 'BPSK'.

c) **iq-channel-options.** This attribute specifies whether the I, Q, or both channels will be used during the lifetime of the service agreement.

1) Data type/values:

i) 'I only' – only the I channel used;

ii) 'Q only' – only the Q channel used;

iii) 'I&Q' – both I and Q channels used;

iv) 'I or Q deferred' – either I or Q channel may be used (but not both), but the selection is deferred to specification in the service package;

v) 'deferred' – both I and Q channels may be used, but the selection of either or both is deferred to specification in the service package;

vi) 'NA' – not applicable. If the value of modulation-type-options contains only 'BPSK', then this attribute is not applicable.

2) Modifications:  SET shall be disabled at all times.

3) Dependencies:  If the value of *modulation-type-options* contains only 'UQPSK', then this attribute shall only have the values 'I only', 'Q only', or 'I or Q deferred'.

d) **power-ratio-options.** This attribute specifies the set of ratios between the power of the I-channel and the Q-channel in the UQPSK modulation (expressed in dB) that will be available during the lifetime of the service agreement.

1) Data type/values: Subset of the set {3,4,5,6,7,8}.

2) Modifications:  SET shall be disabled at all times.

3) Dependencies:   This attribute is meaningful only if the value of the *modulation-type-option*s attribute has 'UQPSK' as a member.

e) **r-eirp.** This attribute specifies the worst case value for the spacecraft Equivalent Isotropically Radiated Power (EIRP), expressed in dBW.

1) Data type/values:  Integer.

2) Modifications:  SET shall be disabled at all times.

NOTES

1 On the return link the minimal (worst case) spacecraft EIRP is specified whereas on the forward link the maximum and minimum transmitter EIRP are specified.

2 This parameter is used instead of the 'minimum power flux' because it is a spacecraft characteristic and not a parameter which is orbit dependent.

f) **Attribute Value Summary**.  Refer to table 5-2.

**Table 5-2: Attribute Value Summary—R-401SpaceLinkCarrierCharacteristics Managed Object**

| Attribute | Inherited From | Initial Value | Specified In |
|---|---|---|---|
| r-401-carrier-char-mo-id | — | — | CREATE.inv |
| modulation-type-options | — | — | — |
| iq-channel-options | — | — | — |
| power-ratio-options | — | — | — |
| r-eirp | — | — | — |
| waveform-options | 401SpaceLinkCarrier Characteristics (5.1) | — | — |
| modulation-index-range | 401SpaceLinkCarrier Characteristics (5.1) | — | — |
| polarization-options | 401SpaceLinkCarrier Characteristics (5.1) | — | — |
| subcarrier-wave-options | 401SpaceLinkCarrier Characteristics (5.1) | — | — |
| carrier-use-options | SpaceLinkCarrier Characteristics (4.3) | — | — |
| max-frequency | SpaceLinkCarrier Characteristics (4.3) | — | — |
| subcarrier-use-options | SpaceLinkCarrier Characteristics (4.3) | — | — |
| max-subcarrier-freq | SpaceLinkCarrier Characteristics (4.3) | — | — |
| read-me | SLEManagement Entity (reference [15]) | — | — |

## 5.2.6 ACTIONS—R-401SpaceLinkCarrierCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no actions are defined for this managed object class or for its derived classes.

### 5.2.7 STATE-RELATED BEHAVIOR—R-401SpaceLinkCarrierCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no state-related behaviors are defined for this managed object class or for its derived classes.

### 5.2.8 NOTIFICATIONS—R-401SpaceLinkCarrierCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no notifications are defined for this managed object class or for its derived classes.

### 5.2.9 VALIDATION ASPECTS—R-401SpaceLinkCarrierCharacteristics MO CLASS

There are no validation aspects for this managed object. This managed object is created outside the scope of any Service Package, and therefore is not subject to the Service Package validation process.

### 5.3 F-401SpaceLinkCarrierCharacteristics MANAGED OBJECT CLASS

### 5.3.1 PURPOSE

The F-401SpaceLinkCarrierCharacteristics managed object class is a concrete class that specifies the long-term service agreement-level constraints and options pertaining to the RF and modulation characteristics of the forward link of a space link communication system that conforms to *CCSDS 401, Radio Frequency and Modulation Systems* (reference [9]).

### 5.3.2 INHERITANCE—F-401SpaceLinkCarrierCharacteristics MO CLASS

This managed object class is derived from and inherits the properties of the 401SpaceLinkCarrierCharacteristics managed object class.

### 5.3.3 OBJECTS CONTAINED—F-401SpaceLinkCarrierCharacteristics MO CLASS

A F-401SpaceLinkCarrierCharacteristics managed object contains one F-401SymbolStreamCharacteristics managed object, which holds the information about the symbol stream of the forward link. The structure and behavior of the F-401SymbolStreamCharacteristics managed object class is described in 5.5.

### 5.3.4 STATES—F-401SpaceLinkCarrierCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no states are defined for this managed object class.

### 5.3.5 ATTRIBUTES—F-401SpaceLinkCarrierCharacteristics MO CLASS

This managed object class has the following specific attributes:

a) **f-401-carrier-char-mo-id.** This is the naming attribute for this managed object class. It is used to construct the DN.

   1) Data type/values: Character string.

   2) Modifications: SET shall be disabled at all times.

b) **max-eirp.** This attribute specifies the maximum transmitter EIRP, expressed in dBW.

   1) Data type/values: Integer.

   2) Modifications: SET shall be disabled at all times.

c) **min-eirp.** This attribute specifies the minimum transmitter EIRP, expressed in dBW.

   1) Data type/values: Integer.

   2) Modifications: SET shall be disabled at all times.

d) **subcarrier-filter-options.** This attribute indicates the forward subcarrier filters that may be selected during the lifetime of the service agreement.

   1) Data type/values:

      i) 'always wide' – a wide subfilter is always to be used on the subcarrier;

      ii) 'always narrow' - a narrow subfilter is always to be used on the subcarrier;

      iii) 'package option' – either filter is possible, but it is to be selected on a service package basis;

      iv) 'NA' – not applicable.

   2) Modifications: SET shall be disabled at all times.

   3) Dependencies: This attribute must be set to 'NA' if the value of *subcarrier-use-options* is 'never used'.

e) **rf-availability-confirmation.** This attribute indicates the method by which the status of the onboard receiver is to be determined.

   1) Data type/values:

      i) 'use-clcw' - indicates that the NO RF AVAIL flag in the CLCW is to be used to determine acquisition;

      ii) 'rf-ontime' - indicates that RF acquisition is to be assumed after the elapse of a time period sufficient to complete the frequency sweep of the forward carrier.

NOTE – The time period for RF-ontime is calculated directly from the sweep rate and sweep range attributes.

    2) Modifications: SET shall be disabled at all times.

f) **reporting-mcids.** This attribute is a set of Master Channel IDs that are found on the return link virtual channels that carry the CLCWs that report on this forward space link carrier.

    1) Data type/values: Set of (*Version Number*, *SCID*) pairs.

    2) Modifications: SET shall be disabled at all times.

g) An F-401SpaceLinkCarrierCharacteristics managed object has the following subclass-specific constraints on attributes inherited from one of its superclasses:

    1) **waveform-options.** (inherited from 401SpaceLinkCarrierCharacteristics). If the value of the *subcarrier-use-options* attribute is 'always used' or 'deferred', the valid members of the *waveform-options* attribute are 'NRZ-L' and 'NRZ-M'.

    2) **max-subcarrier-freq**. (inherited from SpaceLinkCarrierCharacteristics). For F-401SpaceLinkCarrierCharacteristics, the value of this attribute is constrained to be either 8000 or 16000.

h) **Attribute Value Summary**. Refer to table 5-3.

**Table 5-3:   Attribute Value Summary—F-401SpaceLinkCarrierCharacteristics Managed Object**

| Attribute | Inherited From | Initial Value | Specified In |
|---|---|---|---|
| f-401-carrier-char-mo-id | — | — | — |
| max-eirp | — | — | — |
| min-eirp | — | — | — |
| subcarrier-filter-options | — | — | — |
| rf-availability-confirmation | — | — | — |
| reporting-mcids | — | — | — |
| waveform-options | 401SpaceLinkCarrier Characteristics (5.1) | — | — |
| modulation-index-range | 401SpaceLinkCarrier Characteristics (5.1) | — | — |
| polarization-options | 401SpaceLinkCarrier Characteristics (5.1) | — | — |
| subcarrier-wave-options | 401SpaceLinkCarrier Characteristics (5.1) | — | — |
| carrier-use-options | SpaceLinkCarrier Characteristics (4.3) | — | — |
| max-frequency | SpaceLinkCarrier Characteristics (4.3) | — | — |
| subcarrier-use-options | SpaceLinkCarrier Characteristics (4.3) | — | — |
| max-subcarrier-freq | SpaceLinkCarrier Characteristics (4.3) | — | — |
| read-me | SLEManagement Entity (reference [15]) | — | — |

### 5.3.6   ACTIONS—F-401SpaceLinkCarrierCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no actions are defined for this managed object class or for its derived classes.

### 5.3.7   STATE-RELATED BEHAVIOR—F-401SpaceLinkCarrierCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no state-related behaviors are defined for this managed object class or for its derived classes.

### 5.3.8   NOTIFICATIONS—F-401SpaceLinkCarrierCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no notifications are defined for this managed object class or for its derived classes.

**5.3.9    VALIDATION ASPECTS—F-401SpaceLinkCarrierCharacteristics MO CLASS**

There are no validation aspects for this managed object.  This managed object is created outside the scope of any Service Package, and therefore is not subject to the Service Package validation process.

**5.4    R-401SymbolStreamCharacteristics MANAGED OBJECT CLASS**

**5.4.1    PURPOSE**

An R-401SymbolStreamCharacteristics is a concrete managed object class that represents the service agreement-level management information pertaining to one of the symbol streams transmitted by one CCSDS-401-conformant RF carrier in the space-to-earth direction. The CCSDS-conformant return carrier may carry one or two symbol streams (designated 'I' and 'Q'), and it is possible that different stream characteristics be specified for the I-channel and for the Q-channel.

**5.4.2    INHERITANCE—R-401SymbolStreamCharacteristics  MO CLASS**

This managed object class is derived from and inherits the properties of the SymbolStreamCharacteristics managed object class.

**5.4.3    OBJECTS CONTAINED—R-401SymbolStreamCharacteristics MO CLASS**

An R-401SymbolStreamCharacteristics managed object instance contains no managed object class.

**5.4.4    STATES—R-401SymbolStreamCharacteristics MO CLASS**

Because this managed object class is used to construct the service agreement, no states are defined for this managed object class.

**5.4.5    ATTRIBUTES—R-401SymbolStreamCharacteristics MO CLASS**

This managed object class has the following specific attributes:

a) **r-401-symbol-stream-characteristics-mo-id.** This is the naming attribute for this managed object class. It is used to construct the DN.

   1) Data type/values:  Character string.

   2) Modifications:  SET shall be disabled at all times.

b) **convolutional-coding-options.** This attribute is a set of values that indicate which types of convolutional coding may be used on the symbol stream during the lifetime of the service agreement.

1) Data type/values:

   i) 'not-used' – the absence of convolutional coding on a symbol stream is a valid option for service packages under this service agreement;

   ii) 'rate-one-half' – the use of rate one-half convolutional coding on a symbol stream is a valid option for service packages under this service agreement;

   iii) 'rate-two-thirds' – the use of rate one-half, punctured to two-thirds, convolutional coding is a valid option for service packages under this service agreement;

   iv) 'rate-three-quarters' – the use of rate one-half, punctured to three-quarters, convolutional coding is a valid option for service packages under this service agreement;

   v) 'rate-five-sixths' – the use of rate one-half, punctured to five-sixths, convolutional coding is a valid option for service packages under this service agreement;

   vi) 'rate-seven-eithths' – the use of rate one-half, punctured to seven-eighths, convolutional coding is a valid option for service packages under this service agreement.

2) Modifications: SET shall be disabled at all times.

3) Dependencies:

   i) If there are no members of the set or the only member of the set is 'not-used', then convolutional coding is never used in any service package under the service agreement. In such cases, 'not-used' is the default value for the *convolutional-coding* attribute in a corresponding R-401SymbolStreamPackage managed object and it is not required to specify a value for the *convolutional-coding* attribute in the CREATE invocation for that managed object.

   ii) If there is only one member of the set, then only that type of convolutional coding is permitted for all corresponding symbol streams in all service packages under the service agreement. In such cases, the single member value constitutes the default value for the *convolutional-coding* attribute in a corresponding R-401SymbolStreamPackage managed object and it is not required to specify a value for the *convolutional-coding* attribute in the CREATE invocation for that managed object.

   iii) If there is more than one member of the set, selection of the specific value to be used for the actual carier session is deferred to the individual service

package, where the valid values are constrained to correspond to the members of this set.

c) **Attribute Value Summary**.  Refer to table 5-4.

**Table 5-4:   Attribute Value Summary—R-401SymbolStreamCharacteristics Managed Object**

| Attribute | Inherited From | Initial Value | Specified In |
|---|---|---|---|
| r-401-symbol-stream-characteristics-mo-id | — | — | — |
| convolutional-coding-options | — | — | — |
| max-symbol-rate | SymbolStream Characteristics (4.4) | — | — |
| read-me | SLEManagement Entity (reference [15]) | — | — |

## 5.4.6   ACTIONS—R-401SymbolStreamCharacteristics  MO CLASS

Because this managed object class is used to construct the service agreement, no actions are defined for this managed object class or for its derived classes.

## 5.4.7   STATE-RELATED BEHAVIOR—R-401SymbolStreamCharacteristics  MO CLASS

Because this managed object class is used to construct the service agreement, no state-related behaviors are defined for this managed object class or for its derived classes.

## 5.4.8   NOTIFICATIONS—R-401SymbolStreamCharacteristics  MO CLASS

Because this managed object class is used to construct the service agreement, no notifications are defined for this managed object class or for its derived classes.

## 5.4.9   VALIDATION ASPECTS—R-401SymbolStreamCharacteristics  MO CLASS

There are no validation aspects for this managed object.  This managed object is created outside the scope of any Service Package, and therefore is not subject to the Service Package validation process.

## 5.5    F-401SymbolStreamCharacteristics MANAGED OBJECT CLASS

### 5.5.1    PURPOSE

An F-401SymbolStreamCharacteristics is a concrete managed object class that represents the service agreement-level management information pertinent to one of the symbol streams transmitted via one CCSDS-401-conformant RF carrier in the earth-to-space direction. The CCSDS-conformant forward carrier may carry one symbol stream.

### 5.5.2    INHERITANCE—F-401SymbolStreamCharacteristics  MO CLASS

This managed object class is derived from and inherits the properties of the SymbolStream-Characteristics managed object class.

### 5.5.3    OBJECTS CONTAINED—F-401SymbolStreamCharacteristics MO CLASS

An instance of the F-401SymbolStreamCharacteristics managed object class contains no managed objects.

### 5.5.4    STATES—F-401SymbolStreamCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no states are defined for this managed object class.

### 5.5.5    ATTRIBUTES—F-401SymbolStreamCharacteristics MO CLASS

This managed object class has the following specific attributes:

a) **f-401-symbol-stream-characteristics-mo-id.** This is the naming attribute for this managed object class. It is used to construct the DN.

   1) Data type/values:  Character string.

   2) Modifications:  SET shall be disabled at all times.

b) **bit-lock-confirmation.** This attribute indicates the method by which bit lock confirmation is to be determined.

   1) Data type/values:

      i) 'use-clcw' – indicates that the bit lock indicator in the CLCW is to be used to determine acquisition.

      ii) 'acq-seq-length' – indicates that bit lock confirmation is to be assumed after the elapse of a time period sufficient to complete the transmission of the acquisition sequence.

NOTE – The time period is calculated from the data rate of the symbol stream and the length of the acquisition sequence as specified in the acquisition-sequence-length attribute of the associated F-tc-modulation-channel managed object instance.

c) **reporting-mcids.** This attribute is a set of Master Channel IDs that are found on the return link virtual channels that carry the CLCWs that report on this forward symbol stream.

 1) Data type/values: Each member of the set consists of a (*Version Number, SCID*) pair.

 2) Modifications: SET shall be disabled at all times.

d) **Attribute Value Summary**. Refer to table 5-5.

**Table 5-5:  Attribute Value Summary—F-401SymbolStreamCharacteristics Managed Object**

| Attribute | Inherited From | Initial Value | Specified In |
|---|---|---|---|
| f-401-symbol-stream-characteristics-mo-id | — | — | — |
| bit-lock-confirmation | — | — | — |
| reporting-mcids | —- | —-- | —- |
| max-symbol-rate | SymbolStream Characteristics (4.4) | — | — |
| read-me | SLEManagement Entity (reference [15]) | — | — |

### 5.5.6  ACTIONS—F-401SymbolStreamCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no actions are defined for this managed object class or for its derived classes.

### 5.5.7  STATE-RELATED BEHAVIOR—F-401SymbolStreamCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no state-related behaviors are defined for this managed object class or for its derived classes.

### 5.5.8  NOTIFICATIONS—F-401SymbolStreamCharacteristics MO CLASS

Because this managed object class is used to construct the service agreement, no notifications are defined for this managed object class or for its derived classes.

### 5.5.9 VALIDATION ASPECTS—F-401SymbolStreamCharacteristics MO CLASS

There are no validation aspects for this managed object. This managed object is created outside the scope of any Service Package, and therefore is not subject to the Service Package validation process.

### 5.6 401SpaceLinkCarrierPackage MANAGED OBJECT CLASS

### 5.6.1 PURPOSE

a) The 401SpaceLinkCarrierPackage managed object class is an abstract class that represents the service package-level management information pertaining to the RF and modulation characteristics of a space link communication system that conforms to *CCSDS 401, Radio Frequency and Modulation Systems* (reference [9]). These attributes are inherited by the two concrete subclasses of this class: F-401SpaceLinkCarrierPackage and R-401SpaceLinkCarrierPackage.

b) An instance of a technology-specific concrete subclass of this class is used by SLE Utilization Management and SLE Complex Management to specify the values of the operational parameters of that technology that apply to the service package, within the bounds specified in the corresponding SpaceLinkCarrierCharacteristics-derived managed object.

### 5.6.2 INHERITANCE—401SpaceLinkCarrierPackage MO CLASS

This managed object class is derived from and inherits the properties of the SpaceLinkCarrierPackage managed object class.

### 5.6.3 OBJECTS CONTAINED—401SpaceLinkCarrierPackage MO CLASS

This managed object class is an abstract class; thus it cannot be instantiated and containment relationships do not apply.

### 5.6.4 STATES—401SpaceLinkCarrierPackage MO CLASS

No specific states are defined for this managed object class.

### 5.6.5 ATTRIBUTES—401SpaceLinkCarrierPackage MO CLASS

This managed object class has the following specific attributes:

a) **waveform.** This attribute specifies the waveform to be used on the carrier during the service package.

    1) Data type/values:

        i)  'NRZ-L' – no return to zero-level;

        ii)  'NRZ-M' – no return to zero-mark;

        iii) 'SP-L' – split phase level.

2)  Modifications:  SET shall be enabled in the *waiting* state.

3)  Dependencies:  In an instance of a concrete subclass of 401SpaceLinkCarrier-Package, the value of the waveform attribute is constrained to be one of the values in the set contained in the *waveform-options* attribute of the corresponding 401SpaceLinkCarrierCharacteristics-derived managed object.

b)  **modulation-index.** This attribute specifies the angle by which the RF carrier is phase shifted with respect to the un-modulated RF carrier expressed in milli-radians. ($10^{-3}$ rad).

1)  Data type/values: The value of this attribute is a positive integer.

2)  Modifications:  SET shall be enabled in the *waiting* state.

3)  Dependencies:    In an instance of a concrete subclass of 401SpaceLinkCarrierPackage, the value of the *modulation-index* attribute is constrained to be within the bounds of the value of the *modulation-index-range* attribute of the corresponding 401SpaceLinkCarrierCharacteristics-derived managed object.

NOTE  –   This attribute is meaningful only if the value of the *carrier-use* attribute is 'remnant'.

c)  **polarization.** This attribute indicates the nominal polarization of the RF carrier during the service package.

1)  Data type/values:

        i)  'RHC' – right handed circular;

        ii)  'LHC' – left handed circular.

2)  Modifications:  SET shall be enabled in the *waiting* state.

3)  Dependencies:  In an instance of a concrete subclass of 401SpaceLinkCarrier-Package, the value of the *polarization* attribute is constrained to be within the bounds of the value of the *polarization-options* attribute of the corresponding 401SpaceLinkCarrierCharacteristics-derived managed object.

NOTE  –   This parameter is irrelevant for the return link as long as a ground station supports diversity combination.

d)  **subcarrier-wave.** This attribute specifies the subcarrier waveform to be used during the service package.

1) Data type/values:

   i) 'sine' – sine wave;

   ii) 'square' – square wave.

2) Modifications:  SET shall be enabled in the *waiting* state.

3) Dependencies:   In an instance of a concrete subclass of 401SpaceLinkCarrier-Package, the value of the *subcarrier-wave* attribute is constrained to be within the bounds of the value of the *subcarrier-wave-options* attribute of the corresponding 401SpaceLinkCarrierCharacteristics-derived managed object.

e) **Attribute Value Summary**.  Refer to table 5-6.

**Table 5-6:  Attribute Value Summary—401SpaceLinkCarrierPackage Managed Object**

| Attribute | Inherited From | Initial Value | Specified In |
|---|---|---|---|
| waveform | — | by UM | CREATE.inv |
| modulation-index | — | by UM | CREATE.inv |
| polarization | — | by UM | CREATE.inv |
| subcarrier-wave | — | by UM | CREATE.inv |
| corresponding-characteristics-mo | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| carrier-start-time | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| carrier-stop-time | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| carrier-use | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| frequency | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| subcarrier-use | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| subcarrier-freq | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| read-me | SLEManagement Entity (reference [15]) | by UM | CREATE.inv |

## 5.6.6   ACTIONS—401SpaceLinkCarrierPackage MO CLASS

No specific actions are defined for this managed object class.

## 5.6.7   STATE-RELATED BEHAVIOR—401SpaceLinkCarrierPackage MO CLASS

No class-specific state-related behavior is specified for this class.

**5.6.8   NOTIFICATIONS—401SpaceLinkCarrierPackage MO CLASS**

No specific notifications are defined for this managed object class.  However, notifications are inherited from the SpaceLinkCarrierPackage managed object class.

**5.6.9   VALIDATION ASPECTS—401SpaceLinkCarrierPackage MO CLASS**

No specific validation aspects are defined for this managed object class.

**5.7   R-401SpaceLinkCarrierPackage MANAGED OBJECT CLASS**

**5.7.1   PURPOSE**

The R-401SpaceLinkCarrierPackage managed object class is a concrete class that represents the service package-level management information pertaining to the physical layer of the return link of a space link communication system that conforms to *CCSDS 401, Radio Frequency and Modulation Systems* (reference [9]).

**5.7.2   INHERITANCE—R-401SpaceLinkCarrierPackage MO CLASS**

This managed object class is derived from and inherits the properties of the 401SpaceLinkCarrierPackage managed object class.

**5.7.3   OBJECTS CONTAINED—R-401SpaceLinkCarrierPackage MO CLASS**

An R-401SpaceLinkCarrierPackage managed object contains one or two R-401SymbolStreamPackage managed object(s), which hold(s) the information about the symbol stream(s) of the return link.

The structure and behavior of the R-401SymbolStreamPackage managed object class is described in 5.9.

**5.7.4   STATES—R-401SpaceLinkCarrierPackage  MO CLASS**

No specific states are defined for this managed object class.

**5.7.5   ATTRIBUTES—R-401SpaceLinkCarrierPackage MO CLASS**

This managed object class has the following specific attributes:

   a)   **r-401-carrier-pkg-mo-id.**  This is the naming attribute for this managed object class. It is used to construct the DN.

1)  Data type/values:  Character string.

2)  Modifications:  SET shall be disabled at all times.

b)  **modulation-type.** This attribute indicates the modulation type that will be applied to the RF carrier during the service package.

1)  Data type/values:

    i)   'BPSK' – Binary Phase Shift Key;

    ii)  'QPSK' – Quaternary Phase Shift Key;

    iii) 'UQPSK' – Unbalanced Quaternary Shift Phase Key;

    iv)  'OQPSK' – Offset Quaternary Shift Phase Key.

2)  Modifications:  SET shall be enabled in the *waiting* state.

3)  Dependencies:

    i)   In an instance of a concrete subclass of 401SpaceLinkCarrierPackage, the value of the *modulation-type* attribute is constrained to be within the bounds of the value of the *modulation-type-options* attribute of the corresponding 401SpaceLinkCarrierCharacteristics-derived managed object.

    ii)  If the value of the *carrier-use-options* attribute is 'remnant', the value of this attribute has only one member, 'BPSK'.

c)  **iq-channel.** This attribute specifies whether the I, Q, or both channels will be used during the service agreement.

1)  Data type/values:

    i)   'Q only' – only the Q channel used;

    ii)  'I&Q' – both I and Q channels used;

    iii) 'NA' – not applicable.

2)  Modifications:  SET shall be enabled in the *waiting* state.

3)  Dependencies:

    i)   If the value of *modulation-type* is 'BPSK', then this attribute shall have the value 'NA'.

    ii)  In an instance of a concrete subclass of 401SpaceLinkCarrierPackage, the value of the *iq-channel* attribute is constrained to be within the bounds of the value of the *iq-channel-options* attribute of the corresponding 401SpaceLinkCarrierCharacteristics-derived managed object.

iii) If the value of *modulation-type* is 'UQPSK', then this attribute can only have the values 'I' or 'Q'.

d) **power-ratio.** This attribute specifies the ratio between the power of the I-channel and the Q-channel in the UQPSK modulation (expressed in dB) to be used during the service agreement.

1) Data type/values: Positive integer in the range {3…12}.

2) Modifications: SET shall be enabled in the *waiting* state.

3) Dependencies:

i) In an instance of R-401SpaceLinkCarrierPackage, the value of the *power-ratio* attribute is constrained to be within the bounds of the value of the *power-ratio-options* attribute of the corresponding R-SpaceLinkCarrier-Characteristics managed object.

ii) This attribute is meaningful only if the value of the *modulation-type-options* attribute has 'UQPSK' as a member.

e) **Attribute Value Summary**. Refer to table 5-7.

**Table 5-7:** **Attribute Value Summary—R-401SpaceLinkCarrierPackage Managed Object**

| Attribute | Inherited From | Initial Value | Specified In |
|---|---|---|---|
| r-401-carrier-pkg-mo-id | — | by CM | CREATE.inv |
| modulation-type | — | by UM | CREATE.inv |
| iq-channel | — | by UM | CREATE.inv |
| power-ratio | — | by UM | CREATE.inv |
| waveform | 401SpaceLinkCarrier Package (5.6) | by UM | CREATE.inv |
| modulation-index | 401SpaceLinkCarrier Package (5.6) | by UM | CREATE.inv |
| polarization | 401SpaceLinkCarrier Package (5.6) | by UM | CREATE.inv |
| subcarrier-wave | 401SpaceLinkCarrier Package (5.6) | by UM | CREATE.inv |
| corresponding-characteristics-mo | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| carrier-start-time | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| carrier-stop-time | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| subcarrier-use | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| subcarrier-freq | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| carrier-use | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| frequency | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| read-me | SLEManagement Entity (reference [15]) | by UM | CREATE.inv |

### 5.7.6   ACTIONS—ACTIONS—R-401SpaceLinkCarrierPackage MO CLASS

No specific actions are defined for this managed object class.

### 5.7.7   STATE-RELATED BEHAVIOR—R-401SpaceLinkCarrierPackage MO CLASS

No class-specific state-related behavior is specified for this class.

### 5.7.8   NOTIFICATIONS—R-401SpaceLinkCarrierPackage MO CLASS

No specific notifications are defined for this managed object class.  However, notifications are inherited from the SpaceLinkCarrierPackage managed object class.

**5.7.9   VALIDATION ASPECTS—R-401SpaceLinkCarrierPackage MO CLASS**

No specific validation aspects are defined for this managed object class.

**5.8   F-401SpaceLinkCarrierPackage MANAGED OBJECT CLASS**

**5.8.1   PURPOSE**

The F-401SpaceLinkCarrierPackage managed object class is a concrete class that represents the service package-level management information pertaining to the physical layer of the forward link of a space link communication system that conforms to *CCSDS 401, Radio Frequency and Modulation Systems* (reference [9]).

**5.8.2   INHERITANCE—F-401SpaceLinkCarrierPackage MO CLASS**

This managed object class is derived from and inherits the properties of the 401SpaceLinkCarrierPackage managed object class.

**5.8.3   OBJECTS CONTAINED—F-401SpaceLinkCarrierPackage MO CLASS**

An F-401SpaceLinkCarrierPackage managed object contains one F-401SymbolStreamPackage managed object, which holds the information about the symbol stream of the forward link.

The structure and behavior of the F-401SymbolStreamPackage managed object class is described in 5.10.

**5.8.4   STATES—F-401SpaceLinkCarrierPackage MO CLASS**

No specific states are defined for this managed object class.

**5.8.5   ATTRIBUTES—F-401SpaceLinkCarrierPackage MO CLASS**

This managed object class has the following specific attributes:

  a) **f-401-carrier-pkg-mo-id.**  This is the naming attribute for this managed object class. It is used to construct the DN.

   1)  Data type/values:  Character string.

   2)  Modifications:  SET shall be disabled at all times.

  b) **eirp.** This attribute specifies the transmitter EIRP, expressed in dBW.

   1)  Data type/values:  Integer.

   2)  Modifications:  SET shall be enabled in the *waiting* state.

3) Dependencies: The value of this attribute is constrained to be within the bounds of the values of the *max-eirp* and *min-eirp* attributes of the corresponding F-401SpaceLinkCarrierCharacteristics managed object.

c) **subcarrier-filter.** This attribute indicates the forward subcarrier filter to be used during the space link session.

1) Data type/values:

   i) 'wide' – a wide subfilter is to be used on the subcarrier;

   ii) 'narrow' – a narrow subfilter is to be used on the subcarrier;

   iii) 'NA' – not applicable.

2) Modifications: SET shall be enabled in the *waiting* state.

3) Dependencies: This attribute must be set to 'NA' if the value of *subcarrier-use* is 'not used'.

d) **sweep-range.** This attribute specifies the carrier frequency sweep range (in kHz) for the forward link.

1) Data type/values: Positive integer.

2) Modifications: SET shall be enabled in the *waiting, configured,* and *operational* states.

e) **sweep-rate.** This attribute specifies the carrier frequency sweep rate (in kHz/s) for the forward link.

1) Data type/values: Positive integer.

2) Modifications: SET shall be enabled in the *waiting, configured,* and *operational* states.

f) An F-401SpaceLinkCarrierPackage managed object has the following subclass-specific constraint on an attribute inherited from one of its superclasses:

**subcarrier-freq**. (inherited from SpaceLinkCarrierPackage). For R-401SpaceLinkCarrierPackage, the value of this attribute is constrained to be either 8000 or 16000. The value of 16000 is valid only if the value of *max-subcarrier-freq* is 16000 in the corresponding F-401SpaceLinkCarrier-Characteristics managed object.

g) **Attribute Value Summary**. Refer to table 5-8.

**Table 5-8:  Attribute Value Summary—F-401SpaceLinkCarrierPackage Managed Object**

| Attribute | Inherited From | Initial Value | Specified In |
|---|---|---|---|
| f-401-carrier-pkg-mo-id | — | by CM | CREATE.inv |
| eirp | — | by UM | CREATE.inv |
| subcarrier-filter | — | by UM | CREATE.inv |
| sweep-range | — | by UM | CREATE.inv |
| sweep-rate | — | by UM | CREATE.inv |
| waveform | 401SpaceLinkCarrier Package (5.6) | by UM | CREATE.inv |
| modulation-index | 401SpaceLinkCarrier Package (5.6) | by UM | CREATE.inv |
| polarization | 401SpaceLinkCarrier Package (5.6) | by UM | CREATE.inv |
| subcarrier-wave | 401SpaceLinkCarrier Package (5.6) | by UM | CREATE.inv |
| carrier-use | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| frequency | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| corresponding-characteristics-mo | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| carrier-start-time | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| carrier-stop-time | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| subcarrier-use | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| subcarrier-freq | SpaceLinkCarrier Package (4.5) | by UM | CREATE.inv |
| read-me | SLEManagement Entity (reference [15]) | by UM | CREATE.inv |

## 5.8.6   ACTIONS—F-401SpaceLinkCarrierPackage MO CLASS

No specific actions are defined for this managed object class.

## 5.8.7   STATE-RELATED BEHAVIOR—F-401SpaceLinkCarrierPackage MO CLASS

No class-specific state-related behavior is specified for this class.

## 5.8.8   NOTIFICATIONS—F-401SpaceLinkCarrierPackage MO CLASS

No specific notifications are defined for this managed object class.  However, notifications are inherited from the SpaceLinkCarrierPackage managed object class.

**5.8.9    VALIDATION ASPECTS—F-401SpaceLinkCarrierPackage MO CLASS**

No specific validation aspects are defined for this managed object class.

**5.9    R-401SymbolStreamPackage MANAGED OBJECT CLASS**

**5.9.1    PURPOSE**

An R-401SymbolStreamPackage is a concrete managed object class that represents the service package-level management information pertaining to one of the symbol streams transmitted by one CCSDS-401-conformant RF carrier in the space-to-earth direction. The CCSDS-conformant return carrier may carry one or two symbol streams (designated 'I' and 'Q'), and it is possible that different stream characteristics be specified for the I-channel and for the Q-channel.

**5.9.2    INHERITANCE—R-401SymbolStreamPackage MO CLASS**

This managed object class is derived from and inherits the properties of the SymbolStreamPackage managed object class.

**5.9.3    OBJECTS CONTAINED—R-401SymbolStreamPackage MO CLASS**

An R-401SymbolStreamPackage managed object contains one R-af-prod managed object. Presence of an instance is mandatory.  This managed object class is described in *Service Management* (reference [15]).

**5.9.4    STATES—R-401SymbolStreamPackage MO CLASS**

No specific states are defined for this managed object class.

**5.9.5    ATTRIBUTES—R-401SymbolStreamPackage MO CLASS**

This managed object class has the following specific attributes:

  a) **r-401-symbol-stream-package-mo-id.** This is the naming attribute for this managed object class. It is used to construct the DN.

  1) Data type/values:  Character string.

  2) Modifications:  SET shall be disabled at all times.

  b) **convolutional-coding.** This attribute indicates whether convolutional coding is to be used on the symbol stream during the carrier session, and if so, what type of convolutional coding.

1) Data type/values:

   i) 'not-used' – convolutional coding is not used on this symbol stream in this service package;

   ii) 'rate-one-half' – rate one-half convolutional coding is used on this symbol stream in this service package;

   iii) 'rate-two-thirds' – rate one-half, punctured to two-thirds, convolutional coding is used on this symbol stream in this service package;

   iv) 'rate-three-quarters' – the use of rate one-half, punctured to three-quarters, convolutional coding is used on this symbol stream in this service package;

   v) 'rate-five-sixths' – the use of rate one-half, punctured to five-sixths, convolutional coding is used on this symbol stream in this service package;

   vi) 'rate-seven-eithths' – the use of rate one-half, punctured to seven-eighths, convolutional coding is used on this symbol stream in this service package.

2) Modifications: SET shall be enabled in the *waiting* state.

3) Dependencies: The valid values for this attribute are constrained by the values of the *convolutional-coding-options* attribute of the corresponding R-401SymbolStreamCharacteristics managed object as follows:

   i) If there are no members of the set-valued *convolutional-coding-options* attribute or the only member of the set is 'not-used', then the only valid value for this attribute is 'not-used'. In such cases, 'not-used' is the default value and it is not required to specify a value for the attribute in the CREATE invocation for this R-401SymbolStreamPackage managed object. Only the value 'not-used' may be specified in the CREATE invocation. Any other value shall result in a validation error.

   ii) If there is only one member of the set-valued *convolutional-coding-options* attribute then the only valid value for this attribute is that specified value. In such cases, that specified value is the default value and it is not required to specify a value for the attribute in the CREATE invocation for this R-401SymbolStreamPackage managed object. Only the specified value may be specified in the CREATE invocation. Any other value shall result in a validation error.

   iii) If there is more than one member of the set-valued *convolutional-coding-options* attribute, then a value must be specified in the CREATE invocation for this managed object. The value shall be constrained to the members of the *convolutional-coding-options* attribute.

c) **bit-sync-acq-time**. The time of the initial acquisition of bit synchronization during the carrier session.

1) Data type/values: CCSDS time code.

2) Modifications:

    i) GET shall be enabled in all states of the containing CarrierPackage MO;

    ii) SET shall be disabled in all states of the containing CarrierPackage MO.

d) **bit-sync-loss-time**. The time of the most recent loss of bit synchronization during the carrier session.

1) Data type/values: CCSDS time code.

2) Modifications:

    i) GET shall be enabled in all states of the containing CarrierPackage MO;

    ii) SET shall be disabled in all states of the containing CarrierPackage MO.

e) **Attribute Value Summary**. Refer to table 5-9.

**Table 5-9:** **Attribute Value Summary—R-401SymbolStreamPackage Managed Object**

| Attribute | Inherited From | Initial Value | Specified In |
|---|---|---|---|
| r-401-symbol-stream-package-mo-id | — | by CM | CREATE.inv |
| convolutional-coding | — | by UM | CREATE.inv |
| bit-sync-acq-time | — | by CM | — |
| bit-sync-loss-time | — | by CM | — |
| corresponding-characteristics-mo | SymbolStreamPackage (4.6) | by UM | CREATE.inv |
| symbol-rate | SymbolStreamPackage (4.6) | by UM | CREATE.inv |
| read-me | SLEManagement Entity (reference [15]) | by UM | CREATE.inv |

**5.9.6 ACTIONS—R-401SymbolStreamPackage MO CLASS**

No specific actions are defined for this managed object class.

**5.9.7 STATE-RELATED BEHAVIOR—R-401SymbolStreamPackage MO CLASS**

No class-specific state-related behavior is specified for this class.

**5.9.8   NOTIFICATIONS—R-401SymbolStreamPackage MO CLASS**

No specific notifications are defined for this managed object class.


**5.9.9   VALIDATION ASPECTS—R-401SymbolStreamPackage MO CLASS**

No specific validation aspects are defined for this managed object class.

**5.10   F-401SymbolStreamPackage MANAGED OBJECT CLASS**

**5.10.1   PURPOSE**

An F-401SymbolStreamCharacteristics is a concrete managed object class that represents the service package-level management information pertinent to one of the symbol streams transmitted via one CCSDS-401-conformant RF carrier in the earth-to-space direction. The CCSDS-conformant forward carrier may carry one symbol stream.


**5.10.2   INHERITANCE—F-401SymbolStreamPackage MO CLASS**

This managed object class is derived from and inherits the properties of the SymbolStreamPackage managed object class.


**5.10.3   OBJECTS CONTAINED—F-401SymbolStreamPackage MO CLASS**

An instance of this concrete managed object class shall contain instances of the following classes:

   a) F-tc-session-prod managed object.  Presence of an instance is mandatory if Telecommand protocols are used on the forward Space Link.  This managed object class is described in *Service Management* (reference [15]).

   b) F-pca-pdu-prod managed objects.  Presence of an instance is mandatory if AOS protocols are used on the forward Space Link.  This managed object class is described in *Service Management* (reference [15].


**5.10.4   STATES—F-401SymbolStreamPackage MO CLASS**

No specific states are defined for this managed object class.


**5.10.5   ATTRIBUTES—F-401SymbolStreamPackage MO CLASS**

This managed object class has the following specific attributes:

a) **f-401-symbol-stream-package-mo-id.** This is the naming attribute for this managed object class. It is used to construct the DN. It is a character string.

b) **first-symbol-gen-time**. The time of the generation of the first symbol on the symbol stream during the carrier session.

   1) Data type/values: CCSDS time code.

   2) Modifications:

      i) GET shall be enabled in all states of the containing CarrierPackage MO;

      ii) SET shall be disabled in all states of the containing CarrierPackage MO.

c) **last-symbol-gen-time**. The time of the generation of the most recent symbol on the symbol stream during the carrier session.

   1) Data type/values: CCSDS time code.

   2) Modifications:

      i) GET shall be enabled in all states of the containing CarrierPackage MO;

      ii) SET shall be disabled in all states of the containing CarrierPackage MO.

d) **Attribute Value Summary**.  Refer to table 5-10.

**Table 5-10:  Attribute Value Summary—F-401SymbolStreamPackage Managed Object**

| Attribute | Inherited From | Initial Value | Specified In |
|---|---|---|---|
| f-401-symbol-stream-package-mo-id | — | by CM | CREATE.inv |
| first-symbol-gen-time | — | by CM | — |
| last-symbol-gen-time | — | by CM | — |
| corresponding-characteristics-mo | SymbolStreamPackage (4.6) | by UM | CREATE.inv |
| symbol-rate | SymbolStreamPackage (4.6) | by UM | CREATE.inv |
| read-me | SLEManagement Entity (reference [15]) | by UM | CREATE.inv |

## 5.10.6  ACTIONS—F-401SymbolStreamPackage MO CLASS

No specific actions are defined for this managed object class.

## 5.10.7  STATE-RELATED BEHAVIOR—F-401SymbolStreamPackage MO CLASS

No class-specific state-related behavior is specified for this class.

**5.10.8  NOTIFICATIONS—F-401SymbolStreamPackage MO CLASS**

No specific notifications are defined for this managed object class.

**5.10.9  VALIDATION ASPECTS—F-401SymbolStreamPackage MO CLASS**

No specific validation aspects are defined for this managed object class.

# ANNEX A

# SPACE LINK PHYSICAL LAYER ACRONYMS

This annex is **not** part of the draft Recommendation.

This annex identifies the acronyms used in this document.

| | |
|---|---|
| AOS | Advanced Orbiting System |
| CCSDS | Consultative Committee for Space Data Systems |
| CLCW | Command Link Control Word |
| CLTU | Command Link Transmission Unit |
| CM | SLE Complex Management |
| CMIS/CMIP | Common Management Information Service/Protocol |
| CORBA | Common Object Request Broker Architecture |
| DCE | Distributed Computing Environment |
| DCOM | Distributed Component Object Model |
| DN | Distinguished Name |
| EIRP | Equivalent Isotropically Radiated Power |
| GDMO | Guidelines for the Description of Managed Objects |
| LOS | Loss of Signal |
| MDOS | Mission Data Operations System |
| MO | Managed Object |
| OCF | Operational Control Field |
| OSI | Open Systems Interconnection |
| RF | Radio Frequency |
| SCID | Spacecraft Identification |
| SLE | Space Link Extension |
| SNMP | Simple Network Management Protocol |
| TC | Telecommand |
| UM | SLE Utilization Management |